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The Piece Rate System in Manufacturing

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THE PIECE RATE SYSTEM IN MANUFACTURING

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

EDWIN LYMAN MAYALL. B. S.

ENTITLED THE PIECE RATE SYSTEM IN MANUFACTURING

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

OF Mechanical Engineer

L. P. Breckenridge

HEAD OF DEPARTMENT OF Mechanical Engineering

THE PIECE WORK SYSTEM OF MANUFACTURING.

Every superintendent of manufacturing, and in fact all those who make up the managing corps of a manufacturing institution, are concerned with the problem, "A lower labor cost of production." This is due to the sharp competition that exists today along all industrial lines of work and the imperative need of making the business a profitable one.

Of all the outlets of money in an industry it is this--the payroll--that the superintendent does and must guide and control.

The ways and methods promulgated and executed for the solution of this most important and cardinal subject are many. Such are ever changing, ever increasing, due to the marvelous and rapid strides or advancements that are being made in the engineering world today.

Modern and special machinery, high speed cutting tools of all kinds, including both metal and wood, ingenious machine and bench attachments, etc.,-all these have been and are changing the labor cost, and often times several hundred per cent.

However, a manufacturing plant may be complete in modern machinery and appliances, the arrangement and installation of labor saving devices may be perfect, yet with all this, a minimum labor cost will not and cannot be secured, until at such a time as the employees are guided and directed by some means or system in order that the employer may secure a good day's output of work, and thus a good return for

money invested. For it is true that an operator of an old machine and user of tools, will not deliver to his employer a maximum output from a new machine or appliance, due principally to two reasons. First, lack of knowledge of the increased effectiveness of new machinery, and second, to avoid over-work as he may consider. This is true in all cases and instances, as well of old and unchanged methods of manufacturing as of new.

The laborer, the mechanic, and all have and do serve their own personal interest by always and unceasingly endeavoring to secure the highest rate of wages for the least day's work.

It is such conditions that have led superintendents to realize the need of putting forward and into operation some inducement, some incentive, some force, or some system that will appeal to and compel the workman to deliver to his employer a good day's work for a good day's pay.

Systems that have been invented to secure this result set forth a relation between output and earnings, the latter depending directly upon the former.

It is true that theoretically a manufacturer would realize the lowest labor cost by the pure and simple day work system, a system that pays the workman according to the time he may work, for the reason that men will work for a lower rate of pay under this system than any or all others. In practice this system has been and is an ignominious failure, and with it in force, the large manufacturer in particular is burdened with the highest labor cost. He may scheme, threaten and resort to all known and unknown ways in an effort to force the workman to rapid work throughout the working hours, but all to little or no permanent avail. The superintendent, his assistants, the foremen, and all concerned in the management may exert this same

effort, with the same result. For in the general make-up of the laboring class, particularly the unskilled class, are men who serve their own interest first and naturally so, for in following such a course is but the carrying out of the first law of self preservation.

The piece rate system was inaugurated to meet this condition and to correct the existing evil. When this took place, the workman demanded more pay per day's work; he will and does advance the argument: "I am compelled to do more work per unit time, in return I demand more pay." His argument has been conceded by the manufacturer and rightly so, due to the man's increased efficiency. The system has wrought good to both employer and employee. It has resulted in a lower labor cost of production to the former and increased earnings to the latter.

The piece work system has been expanded into various and varied forms, some of which are:-

"Bonus System for Rewarding Labor", H. L. Gantt;
"Gift Proposition for Paying Workmen", Frank Richards;
"Gain Sharing", Henry R. Towne,
"Premium Plan of Paying for Labor", F. A. Halsey.

All of which are clearly defined in Fred Taylor's paper in Transactions A. S. M. E., Vol. 24.

All these systems have been invented for the purpose of avoiding the evils of the pure and simple Piece Work System. Such inventions for such a purpose are open to criticism, for the reason that generally it is proper and right to apply a remedy directly to the cause of existing short-comings of a system. The question, "what are these evils of the piece work system", should be asked and investigated. Then right those erroneous matters that prevent the successful operation of the system; this before devising and using a system

to avoid.

The past and ever present fault of the piece work system as operated today by many and in fact most manufacturers, is not in the system itself, but lies with those responsible for its application. The usual practice is for a superintendant to order of his foremen a reduction in piece work prices, this generally at the end of each manufacturing season, thus forcing his foremen to make a demand upon the men for concessions. The common procedure in carrying out such a plan is as follows:-The laborer or mechanic submits what he will do the work for, the foreman looks it over and in most cases will set a lower figure. The wrangle then begins, and generally ends by the two splitting the difference.

In some cases this program is followed at each and every time, that the piece worker may earn what his employer may consider high wages. These ways of operating the piece work system I know to be a fact, and to exist in many of the large industrial institutions that I have visited and thoroughly inspected.

What is the natural result of all this? The men and foremen harbor an ill frame of mind, discontent is bred, men limit their day's work, and instead of increasing their efficiency, such will become dormant or inactive, and in some cases, recede.

Again, men will be doing more like and similar work for their day's earnings than others, for it is perfectly true by the pursuit of such a policy as herein and just noted, that some prices may be unjustly low and others too high.

This fact becomes known to the men quicker than little realized, for the same work may be done by different men at different times, and it is then that the foreman is accused of partiality, a serious

complaint and a difficult one to explain in relieving the men of the idea.

It is these reasons that have often times condemned the piece work system by both men and the shop management. Why? All because accurate knowledge of the situation, the questions, and all that pertains to a proper and just day's work was not known.

I have always carried in mind Goethe's remarkable and strong quotation, "Talent is developed in solitude, but character in the world's strains of life". Along the same lines this can be amplified to apply to the shop manager. Questions are never settled unless settled right; it is the solution of details that solves, and the full operation of these details masters the question.

At the time I was put in charge of the rate fixing department at Deere & Co., the piece work system was in operation as just described, with this difference:-all prices after the regular yearly reduction were contracted for the issuing manufacturing year. This company has two forms of contract as shown on plates 1 and 2. The first is the workman's contract with the company when there is no change in prices for the signer's work. The second is used to embrace changes made, by specifying on the blank side of the contract those changes, or referring to them, by writing "As per prices posted". In this connection I wish to mention that all prices pertaining to a department are posted in that department in blue print frames with glass fronts. Such a frame and specimen piece work price sheet are shown by photograph on plates 3 and 4. In this way, men at all times have access to prices; such an arrangement is especially convenient for foremen, for they need not give any of their time to informing old or new men concerning prices.

Naturally, the piece work system as in operation, was not satisfactory. This was discovered and realized in two ways; first, the company was spending large amounts of money each year for improvements, but with little gain made in lower labor cost or cost of production and generally but little gain in output of plant. This may appear strange on the face of it, so will mention that detailed illustrations will follow later in this paper. Second, by familiarizing ourselves with prices, methods, wages and production of other manufacturers. Included in the list were companies who had not made the extended improvements that we had, yet whose labor cost was just as low or lower, and earnings of men, approximately the same.

These two strong and non-suppressible evidences led to a close, thorough and deep study of the situation, and brought us face to face with the problem, "what to do". This problem was assigned to the writer.

My previous experiences while Master Mechanic of the Acme Harvester Co. pertained more to methods of manufacturing rather than to prices.

The piece work system was operated by that company in the same and usual faulty way as has been suggested. So a thorough investigation was conducted in search of a reliable labor wage system and for one that would be applicable to the plow business; a business made up of an almost infinite number of details and conditions.

This investigation was carried on vigorously for a period extending over three months and included a study of all systems relating to the labor wage question, and where possible, the actual results of the practical application of those systems.

At the end of this time it was decided to continue the use of the pure and simple piece work system, but properly apply it by the use of Mr. Fred Taylor's system of elementary timing investigation of all the work; and further, after prices were determined in this way, these were to be contracted as in the past and to remain constant for all time to come, regardless of the earnings of the men, with certain provisos as will be mentioned.

Further, all prices to be figured upon a certain rate, this rate depending upon the amount of skill required by the work and upon local conditions. The latter consideration was especially important, for it is true that a manufacturer will have to pay approximately the rate of wages for a certain class of work equal to that of his neighbors. However, this rate can generally be reduced by having improved conditions as compared with other local manufacturing institutions.

Will mention in this connection that the basis of labor wage or rate can be governed by the considerations just noted, except when such are governed by unionized labor.

Further, it was decided to inform the men involved by new prices what this rate was, and to guarantee that a man of average ability could earn the rate--this to hold true at all times and to be included in the workman's contract. To cover this, we now write upon the blank side of the contract the rate at which prices are based and guarantee the same. This policy has been, and rightly so, strictly carried out in all cases. Still further, these decisions arrived at concerning the adopted system were clearly and promiscuously published and circulated, and the men strongly impressed that such was going to be the policy of the company, and especially that wages earned higher than the rate upon which prices were

based would lead to no reduction in price, but would lead the company to realize that such men were of unusual skill, and the company would show preference in retaining such men permanently, rather than others who had not displayed skill in that way.

Rates are mentioned and guaranteed for the purpose of not lead- the men to believe that the company is assuming a despotic and therefore unfair position, but that the company was willing at all times to prove the correctness of the investigation and the prices set.

Such a position to assume by a company in the operation of the system herein described, is absolutely the strongest one to adopt and will and must appeal to all men, the fairness of the same.

If the reader will pardon the digression, I will mention the saying as quoted by Abraham Lincoln;-"Let us remember that right makes might, and let us to the end, dare to do our duty as we understand it".

If manufacturers would follow this rule instead of the one that might makes right, there would be no need of unionized labor.

To return to the subject, I am safe in saying that every two out of three prices that have been set by the system now in use, have required the attention of the writer or his assistants to stay with workmen, manage the details of the work, show him where he is losing time and how to gain time, to do the work, and how to come up to a good day's work and become an efficient man. At times, by keeping in such close contact with the operation of the system, errors of assumptions and calculations have been discovered. In such cases the error is frankly and openly acknowledged, the mistake remedied at once, and any loss in wages or time that the workman has suffered, is immediately made good.

As an illustration, it has happened that a workman has worked along for several weeks, doing his very best as he knows how, and in a conscientious way, but is unable to earn the guaranteed rate. This may be due to the rate fixing department not having the time to take the matter up, or due to the timidity of the man. In such cases if the cause is an error, the loss entailed by the man in dollars and cents is made up to him in a lump sum.

The result of this can easily be conceived, which is the establishing of the strictest confidence between employer and employee.

It has happened that an error is discovered during this putting into operation of the new price that favors the man. For this condition of affairs we have not made the rule work both ways but have followed this course:--Explain in detail to the workman that such has been found and the correction is made to take effect at the beginning of the following manufacturing season. Such mistakes are very unfortunate ones to make, for with some men, regardless of what you may say or do, a shadow of doubt will exist in their minds in regard to the constancy of price. For this reason the timer and all associated with the operation of the system as herein noted, must have accuracy as the watch word.

Still further in regard to the adoption and operation of the system, it was decided to insist upon the men earning the rate guaranteed. This was done and is being done for the purpose of weeding out workmen below the average skill and thus keep the whole working force upon an efficient basis, and keep each man's neighbor or coworker a good example to himself; and again for the purpose of keeping up the man's daily production.

So it will be seen that a new price, when once set, does not be-

come permanent until the employee involved earns the rate that the price is based upon. At which time, as previously mentioned, it becomes constant with this proviso:--The company reserves the right to change methods of manufacturing at any time; to follow up such changes with changing prices involved or affected, at once. This is a right that a company should have in order to realize the full effects and advantages of improvements and their corresponding expenditures, and is a right that no union or employee should deny, but instead should co-operate with. To carry out this policy at Deere & Co.'s plant no trouble has arisen, for the affected prices have been re-determined in the same way as the superseded prices.

Changing prices to conform to change of methods of manufacturing must be done honestly and accurately. To perform the latter is generally a matter of simple calculation, for the true value of all elementary operations of the work involved by the change is known and recorded through the elementary timing system. In this connection will mention that when the manufacturer investigates the minutest details of all various operations to complete his product, I believe it is safe to say, that all will discover immediate errors of methods, unnecessary operations, useless and waste expenditures of money, all of which will result in a program of change of methods that will require many years to carry out, and the carrying out of such a program resulting in a saving of large amounts of money.

All of this being particularly true when the rate fixing and methods of manufacturing departments are closely associated.

At the start we conducted the rate fixing department as a distinct and separate one. However, in a short time, after minute timing investigations were in progress, questions of method were as numerable as questions of prices, consequently from that time to

this, these two departments have been conducted as one, which arrangement has proven par excellence. Our men that attend to the timing operations are impressed with this one idea, and that is to make and carry out the work of timing to pertain to both method and actual time to perform the operations of the work.

The men that we have delegated to this work have been up to the present time high grade technical men, men to whom we give every attention to develop into the details of the business; give them considerable latitude and sustain them in their work, ever mindful of looking after their experience in such ways as having them step into the ranks of the workmen and perform their work; give them the experience of an assistant foreman, etc.; and both the superintendent and assistant superintendent keep in contact and watch the details of their work.

All of this development is necessary for the successful operation of the piece work system as described in this paper, especially so when associated with the department of methods of manufacturing. For the reason that the writer has brought together and operated these two departments, in this paper will be given many illustrations of methods developed, which were indeed a direct consequence of the timing system; these I put in for the aid of the student and beginner in following up lines of work pertaining to labor wage systems, and do so for the purpose of suggesting to the same, a few of the observations that they should make in conducting such work.

I have operated the piece work system herein described in no way connected with premium systems. Up to two years ago in a few isolated cases, a premium system was used, but such never appealed to the men, and men showed a distinct preference for the pure and

simple piece work system. For this reason, premium systems made no advance as regards expansion in the plant after such were started.

No premium system ever devised was ever any more proof against cutting of earnings than the piece work system. In addition to this faulty and ruinous operation of these systems, all premium systems can be legitimately and severely criticised for the reason that as a man's output increases beyond the average day's work, he is paid less per piece and instead of his earnings being at all times in direct proportion to his day's work or to the number of pieces pertaining to an operation beyond the average day's work, such becomes an indirect proportion.

This amounts to the fact that the more the employee gains in daily productiveness and efficiency, the more he is fined; in other words, he is compelled to share with his employer the profits of his own increased efforts, but surely a profit that belongs to the workman and the workman alone. Such unfairness is not imposed upon shop men working under the piece work system. These criticisms of the premium plans of wage payment I believe are almost universally known by employers and shop managers; and I further believe that when such have been installed, the purpose has been for deception and endeavor to lead the workmen to believe, that by its use he will be freed from the apparent monstrosities of the piece work system when operated by whims and notions of the men involved. Such a course followed may be temporary relief; however, the deception, the imposition, the serious faults of the system are bound to become recognized by the workmen in their true light. It is such a climax that leads to strikes and justly so. We expect, require and demand fairness and honesty of the men who work for us, and it is strictly up to the employer to return the compliment .

As regards constancy of piece work prices and rates upon which they are figured, my reader may suggest that such a program is impossible to follow due to changing conditions as a result of political upheavals, internal and external strifes and other dire calamities, all of which disturb the country's condition and affect its prosperity.

All such changes do and have happened and are likely to do so for all ages to come, and hence must be conceded. Again such changes are generally beyond the control of both employer and employee, and do result in industry conditions being disturbed and this renders the necessity of adjusting prices and rates to conform to the new conditions brought about. We cannot deny these facts and these possibilities that are bound to create a disturbance in our industrial institutions, and cannot escape the problem of solution to meet such changes.

Personally, I have never been called upon to adjust prices and rates to meet such situations, but would follow this course if occasion demanded:- I would appeal to the men's sense of justice, clearly and minutely explain causes and reasons; impress upon them the forcible fact that a continuance of the business, a continuance of their and their employer's daily living depended upon the proposed adjustments, rendered and brought about by circumstances beyond our control. And guarantee and assure that all prices set and based upon the new rates should be constant; should be determined in an accurate, scientific, and strictly fair and just way, after a manner that the piece work system is operated at present by the writer at Deere & Co.'s plant. Such an appeal would reap results, for such a course I have followed successfully in establishing new prices on

work that has been done under old conditions for many years with no change in price but now under new conditions due to shop improvements.

Thus after the above discussion, it will be seen that constancy of price, as meant in this description of the successful operation of the piece work system which is the subject of this paper, is constancy of prices as determined by elementary time study at all or any time, regardless of the wage worker's earnings for the same industrial condition.

In this connection I will mention that advanced prices in materials and supplies to the manufacturer do not disturb, and should not disturb, rates in the shop, for invariably such advances are taken care of by increased price of product to the consumer.

Mr. Taylor's paper, Shop Management, explains the principle of elementary timing of work, and gives a few illustrations of its application to some classes of work at the Midvale Steel Co. This paper will describe in lengthy detail how such has been applied to the plow business; will state the innumerable ways and means adopted to secure accurate timing; the way that this system has been applied to meet an almost indefinite number of details as exist in this business; the results gained; the way in which workmen were handled and governed during the process of investigation and during the period that the new prices were being put into full operation. Such details as will be herein noted were developed as the system progressed; were developed as the study of the work advanced, for no publication exists of which the writer knows that could have mapped out the work as conducted. It is for this reason that such details are enumerated, and without a particle of hesitancy, will state that the system can be carried out in the same way by any manufact-

urer of farm machinery. As regards following such a program in other lines of manufacturing, I can see no reason why success would not reward the effort.

At this point it is necessary to state local conditions, for such have a direct effect upon rates and procedure of establishing prices.

Moline is an industrial center, a manufacturing town in every sense of the word, and a town made up of old, large and strong institutions. Wages are high, due to the location of the Government Works on Government Island, known as Rock Island Arsenal, and the extensive main shops of the C. R. I. & P. R. R.; and again due to three large competitive plow manufactories in the same vicinity.

Good workmen, and especially mechanics, are generally in demand the year around. In view of this last named condition, in proceeding with an adjustment of prices by any method, it necessitates the utmost careful handling in order to keep the older men and the mechanics.

As regards unionism, the Tri-Cities,-Davenport, Rock Island and Moline, were up to a few years ago controlled by them. All the various trades were organized and not only the mechanics and skilled labor, but the semi-skilled. Finally conditions became unbearable to the manufacturers, for a continuance of the same would eventually mean ruination. At this time the Tri-City manufacturers were organized and unions were fought to a finish, and today with the exception of the R. I. R. R. shops, all shops are open shops. The principles of this association are printed on the back of each workman's contract, (shown on plates 1 and 2,) and the workman in signing this contract by so doing agrees to accept and abide by those principles.

This Manufacturer's Association is an active one and is the safeguard to the whole industrial makeup of this vicinity.

The piece work system herein described was first applied to the Plow Bottom Fitting Department for these particular reasons:--First, large sums of money had been expended in making improvements in manufacturing the various parts that go to make up the plow bottom, especially so in regard to the forge and tempered parts, but no results had ever been derived, either in decreased labor cost or increased output per man. Second, the department was setting a limit to the output of the whole plant. Third, foremen and assistants all claimed conditions and work did not warrant a reduction in prices, and further such a program could not be carried out. Fourth, the shop management could detect no great loss of time by workmen by walking through the department and taking frequent and casual observation. Fifth, the workmen's earnings as a whole were reasonable and just for this class of work, and compared very favorably with that as earned by the same class of men employed by local competitive companies, and further the quality of the work was perfectly satisfactory, and passed the regular and required inspection.

Naturally this question arose before the minds of the management:-Where and how to get the returns for improvements and expenditures for the same? A careful and close investigation of all the details of the department's work was decided upon and this investigation to be conducted along the lines adopted by Mr. Fred Taylor in his investigation and reorganization of the Midvale Steel Co., and thus endeavor to apply such a system with necessary alterations to meet the conditions and needs of the plow business.

The Plow Bottom Fitting department is

the department where all work is carried on pertaining to the fitting and assembling of all parts constituting the plow bottom, these parts being chiefly share, moldboard, frame or frog, and landside. Due to the great variety of bottoms manufactured by the company, it was generally conceded that it required four years for a fitter's helper to become a fitter, and thus become acquainted with the work in all its details, for due to existing ways of the work, a fitter had to know the construction of one and all bottoms that he received orders for. It will be understood this was no easy task when it is mentioned that the variety of plow bottoms exceeds over 1500 and the necessary gages, templets, jigs and forms for fitting the same require about 5000 in number and again these gages, etc. were promiscuously distributed about the department. No system, classification or index was kept by the company as to their use or location, all such knowledge being carried in the minds of the foremen and men. The personnel of this department was, without an exception, from foreman down to floor sweeper, Swedes, and not only connected intimately through nationality, but religion, friendship and relationship. The full force and power of such bonds and intimacy was discovered as the investigation progressed. All work was done piece work, the prices for which had been established in former years by the foreman of the department. The work was performed by gangs composed of two men, namely, fitter and helper, the company paying the fitter actual earnings determined by the work and prices and he in return paid the helper any per cent that he felt disposed to pay, the division of work or pay being in no way managed by the company.

This was a serious mistake as discovered later, for three reasons. First it was a direct cause for requiring four years to be-

come a fitter, for the helper's advancement was controlled by the fitter himself, and thus his efficiency limited. Second, unfair division of amount of work and earnings. Third, mismanagement by the fitter led to unnecessary delays by causing one or the other of the gang to lose time, for the method pursued was this:--Either fitter or helper would perform a certain series of operations and pass the plow bottom to the other, who in turn would add another series of operations, invariably, as was discovered by the investigation, this division of work was indeed very unequal, all of which led to decreased output and earnings for both men.

As regards the first reason above mentioned, the practice was for the purpose of deception, which was practiced so as to lead the management to think and believe that the character of the work was such as to require great skill and long period of preparation on the part of the apprentice to become a full pledged fitter. All this was for the purpose of keeping the rate of wages for the work high and again to render the fitter's position secure by placing the company upon a distinctly dependent position.

There was but one evidence that prices were not right, all fitters earned the same, thirty cents per hour, at all times and at all kinds of work, and this regardless of time spent upon the work. For illustration, if a fitter lost a day or two days a week, his earnings were the same as when he worked full time. Such was and may always be taken as a strong suggestion that all is not right.

The reader will fully realize now the strong position held by the men of the department, and to introduce a stop watch into the department was a serious and important question as regards ways and means to carry out such a plan, and not for this particular depart-

ment alone, but for the plant itself. It is a hazardous task to time workmen, especially skilled ones, and the timer and the management in connection with operating such a system will always have to display good judgment and carry out the work diplomatically.

Skilled workmen are generally more sensitive than unskilled, for they generally interpret timing of their work as a reflection upon their integrity, honesty and loyalty to the company's interest. In all shops there are good men having every requisite of a loyal and industrious man and the company and the timer must recognize this fact, and in dealing with such men, a heart to heart talk on common and mutual ground is the best thing to dispel this anxiety upon the part of the workman.

It was deemed wise before starting the new piece work system in the fitting department, to call the men of this department together and explain in detail the program that the company intended to follow for the purpose of investigation.

This was done, and both the superintendent and writer made the explanation. Naturally the men defended their position and assured us they were working hard for a fair day's pay. This we in turn conceded, but added hereafter the company intended to and was compelled to carry on an aggressive policy of improving methods of manufacturing so as to increase the shop production and thus meet the stringent demand for the company's product; that the proposed investigation was for this purpose, the purpose of gaining a true insight into the details of the requirements for further improvements. Going into such detail as this: "we want to know why every blow of the hammer is necessary, the cause of every stroke of the chisel and file, the reason of every delay, and not only delays amounting to minutes, but

delays amounting to seconds. We further presumed that there are many misfits of parts due to errors of patterns, dies, or poor workmanship performed in some other department. It is these that we particularly want to correct and to take up with you. Most of you have been closely associated with this work for years, and undoubtedly by co-operating with us at this time could offer many valuable suggestions which we ask for. We fully realize that you consider this work all for the purpose of extensive reduction in price and earnings. As regards prices, we cannot at this time state what the result will be; the investigation will cover, answer and decide that question, however, all resulting changes will be just to one and all, both men and company. And further, if any prices are found low, they will be increased in the same way as high prices will be reduced. As regards earnings or rate, for a good day's work we will guarantee for all work re-adjusted, a piece work rate of thirty cents per hour to fitter, and twenty-seven and one-half cents per hour to helper."

Stating the rates had a marvellously good effect, and mentioning and impressing them with the fact that the investigation was particularly for methods and errors got some of the men interested who began to discuss faulty work, apparent errors, etc.

I have generally found it best to talk matters over with the men, either collectively or individually, before proceeding with any radical departure from the old way of procedure. In this way, considerable valuable information can be obtained, also the confidence of the men; however, at no time or place being diverted from carrying out the system herein enumerated. Once the system started, it should be applied in the same way to all men, for this reason-

men that are being timed often ask the question:-"Why time me on this line of work, and not the other fellow." He will suggest that he is just as honest as the other which may be perfectly true. The only answer to make is that eventually as time permits, the system will embrace every detail of manufacturing. This is the fair and just course for the company to pursue. Often men have presented to the management a scale of new prices representing a large per cent of reduction just for the purpose of avoiding a detailed investigation of their work; it is a great temptation not to accept such propositions when made, nevertheless a company will profit financially and sustain the men's confidence by expending the money and time to carry out the program complete.

Such an instance occurred during the investigation of the Fitting Department. After the work had progressed three weeks, the men got together and offered to the company through the foreman, a voluntary reduction of 16% on the principal line of plows if the investigation would be stopped. This offer was rejected. A second voluntary reduction amounting to 32% was presented in the same way after another three weeks work of investigation had been conducted. This offer suffered the same fate as the first. And well it was, for the company profited by finishing the work started and the reorganization resulted in perfect fairness in all details to both company and men.

The time investigation of plow bottom fitting was conducted as follows. All the various gangs of fitters were timed for the same work and for the most important series of plow bottoms built. The timing period extending from beginning to end-i.e. the fitter would start, say twenty-five bottoms-every second of the time taken to

complete the order was accounted for whether a necessary or unnecessary delay. In other words, we determined exactly how the time was consumed. The work was divided by the timer into its elements, such as time to bolt together parts, if more than one bolt; each bolt timed; time to hammer or rivet the bolt head; time to tighten the nut; time to remove nut from bolt as received from the bolt makers; elementary time to form, fit, grind, chisel, etc., of all parts requiring the same,; time to handle the parts; time to get supplies, dress emery wheel, and maintain bench tools, etc.. These elementary operations of the detail time numbering as high as seventy five for a single plow bottom.

In this connection I would advise those entering into this line of work to divide the work up into short operations; by so doing more accurate and satisfactory results will be obtained for two reasons. First, such will facilitate separating necessary from unnecessary delays of detail time from complete time operations. Second, by following such a course the timer will within a comparatively short time be able to analyze similar work and estimate a very close price without actual timing.

To illustrate the first reason:- Presume the operation of bolting two parts together with two bolts was timed as one operation. Now if the workman should stop during the operation to converse with his neighbor, to rest or be delayed in some way, this delay would necessarily have to be deducted from the time of the whole operation and further such deduction would have to be accurately and quickly done so as to catch the following operation. Now if this work had been divided into smaller elements, such delays need not have been subtracted to eliminate them from the detail time.

As regards the second reason:- A close observer, by storing away in his mind all he has seen and timed, will surprise himself and all others to find how easily it is to analyze similar work and do so quite accurately. The beginner will at first think the data of the system a labyrinth of mixed details with no "head or tail", and a seemingly impossibility to get consistent results.

Time of work is divided into two classes, viz., detail time and complete time. The former defined, means actual time required to do the work itself; the latter, as time required by all necessary delays attendant upon the work itself. Such delays are rest periods, delays occasioned by maintenance of tools and machines used in connection with the work itself; delays occasioned by movement of stock and supplies; delays caused by receiving of instructions pertaining to the work, and all such delays intimately connected, but having an indirect relation to the actual work itself, for the greater amount of time consumed by such delays, the less number of detailed operations that the workman can perform in a unit of time. In other words, complete time is made up of time that the workman has no direct control of; however all such being necessary, as a result of physical requirements and of shop management, and again for which the company has to pay. The timer must always bear in mind this distinction and govern his data accordingly.

The form used by Deere & Co. and designed by the writer for the purpose of timing and recording the data is shown on plate 5. This form has proven very convenient and to meet all needs. For conducting the timing investigations these forms, several in number if need be, are placed in leather bound covers and secured to the same by the four corners and a rubber band passing around the fold of the covers and forms.

As regards the stop watches, two in number are generally used, and are held in the palm of either hand, a watch being of such size that it does not interfere with one's writing when holding pencil and watch in the same hand. We have found such an arrangement more convenient and accurate than the combination watch case and data book as described in Mr. Taylor's paper on Shop Management. The timer will be compelled in following different elements of work to make almost instantaneous watch readings in order to catch successive and following detail operations with the least possible error.

The timing in the fitting department, and as conducted at the present date throughout the plant, was done so, known and unknown to the workman, for the purpose of checking results; the method to be adopted in all cases must be determined by the timer's judgment of the work and the man doing the work, but when in any doubt whatever he should apply both methods.

As regards the securing of accurate detail time and complete time, one of the most important questions that will arise in the mind of one attempting the piece work system herein described. I shall answer this question by illustrating in detail the course pursued to secure such in the fitting department.

During the whole period consumed by the investigation the men did not and would not, exceed their regular and past earnings, which was evidence of a prearranged limit set and followed by the men, not only the year of investigation, but in past years. The writer bribed, threatened, pleaded and tried all diverse means to destroy the limit as being rigidly followed. However, all to no avail, for the men imagined by following such a course, that such would prove their contention that prices and day's work were just

and good.

Although the men did and will deceive the company in time required to complete an operation and do so exceedingly cleverly, no workman can deceive all the time in performing the elements of that complete operation. Such is an impossibility for any man to do unless he should have himself governed by a stop watch in the hands of a dictator who would call off the seconds as when to start and to stop, he working conscientiously in the meanwhile. It is this one fact that makes the system a successful one, and a fact true at all times under all conditions.

As investigation progressed in the Fitting department, the situation became quite critical; the men held regular stated nightly meetings; they secured a past assistant superintendent of the company to organize them and help win the fight. All this and more suggested to us a rejection of the new reorganization and prices when the same took effect, which was to be the following manufacturing year. The men's contract, however, prevented them from taking action during the year of investigation.

To meet these conditions the company assumed that there would either be a strike or all the old fitters and helpers would quit; We laid our plans accordingly. The writer made many trips to other cities and selected with the greatest of care first class and reliable bench men. All of these men were informed of the true condition of affairs and the position as was to be assumed and maintained by the company. Such arguments in connection with a guarantee of higher wages and steadier work secured a good force of such men. These men were put to work, one and two at a time, as helpers to the old fitters, though no old men were laid off to accomplish

this, and such additions meant increase of force. As the new men were securing their training which was extended over a period of about four weeks, the writer to check all data concerning plow bottom fitting and thus render the company's position secure, familiarized himself with every detail by performing personally the work itself. As a result of this and a close study of the data we came to the conclusion that we could make full fledged plow fitters in about three week's time instead of four years. This was accomplished by organizing two large crews of men, and so dividing the work that each man would have but a few operations to perform, at the end of which he would pass the parts to his neighbor and so on to the last man who would place the finished bottom on the floor ready for inspection. Thus instead of one man learning say seventy-five operations he only learned ten or less. These crews the writer organized by taking our new men and adding a sufficient number of our best and willing roustabouts to complete the crew. For by dividing up the work so fine, series of operations were so grouped that the simplest and those requiring no skill came together and thus for the performance of these a common laborer would do, and did do, just as well as a skilled mechanic. One crew was organized to build one class of plows, and a second crew to build another class, both classes embracing about 80% of the total output of all plows built by the company. Each crew was put under a contractor who had charge of the work and men. However, both contractors and men were governed in all details by the writer. The workman of these crews did their work at the new prices determined by the investigation, but the contractor was paid on the basis of the then existing scale, so he was the beneficiary by securing the difference, which indeed

reached vast proportions. By following such a course, the company fulfilled the terms of its contract by not paying any less for the work, and secured strong support and co-operation from the contractor, the latter particularly, due to the contractor's immense earnings. At the start all men of the crew were guaranteed a certain rate, said rate continued until they could earn a higher rate at the prices given them for their particular operations to perform; this guaranteed rate being much lower than they could eventually earn, and lower than the one the prices were based on. Within less than three weeks the men were earning more money than the old fitters and doing first class work, and working at the new prices which represented a reducing equal to about 35%. And today these crews are doing better work than the company ever received from this department. All due to the simplification of the work, resulting in increased repetition of work per unit time, which is the direct and perfect factor of increasing a workman's efficiency, all other things being equal.

In managing the crews, every result of perfect shop management was afforded. No expense was spared to install every convenience by way of supply of tools, arrangment of machines, special bench fixtures, and attachments. Further, each man was instructed in detail the time to perform each operation of his series, and how well each was to be done, or in other words the limits of variation allowed. He was further instructed the amount of time allowed him for rest, toilet, delays starting up in the morning and afternoon, etc. He was informed exactly what he was expected to do; what he was paid for, and in return for following such a course and thus making himself an efficient and valuable man, his earnings would

be just as first class as his work, and such a program to be followed by him and such earnings to be paid by the company for all times to come with the proviso as has been previously stated.

Further work was done to render the company,s position more secure in preparation of the threatened strike by erecting a tool and check room, in which all tools, jigs, gages, templates, forms, etc., were gathered together, classified, filed away, their purpose and uses recorded; all of which were to be checked out and in. Such an arrangment eliminated the company's dependency from the memory and minds of the men and foremen.

Still further to secure a safe guard so as to make possible the construction of all kinds of plow bottoms by new men Instruction Sheets were designed. A photo of one of these is shown on plate 6. These sheets not only schedule the time and price for each and every operation, but furnish the user with a complete list of all materials, bolts, gages of all kinds, to be used in connection with the plow bottom for which the Instruction Sheet was made out.

Again these Instruction Sheets manage the work as it is to be conducted between fitter and helper, and thus they eliminate unnecessary delays between series of operations as performed by the two men. Such management increases the productiveness of the men and divides the work between the two men equally and justly, and at no time can one impose upon the other as was done in the past.

The reader may suggest that putting into the hands of workmen such detailed instructions would result in confusion especially to workmen of low intelligence. This result would be certain if such instructions were distributed promiscuously amongst such a class of workmen if the company did not take the time and spend the money to

instruct the men thoroughly and in detail as regards the way to use and apply such instructions to their work.

The men engaged in such work of personal instruction must display patience and bear with men possessing slow responding wits. Again such time consumed should result in no less of earnings to the men,for losses in this way would antagonize and make the men irritable, and would result in aversion to the work instead of co-operation. To meet this condition we pay the workmen for all time consumed in such detailed training and the men engaged in that work of training the workmen to adapt themselves to the new organization and new requirements are authorized to allow personally such compensations at any and all times.

The Instruction Sheets are checked in and out of the check room; when checked out they are inserted into a tin frame and covered by a celluloid face. This allows the handling to be done by the workmen without soiling.

These sheets have proved of inestimablevalue not only for the purpose of meeting the conditions herein set forth, but for governing changes in prices due to change of methods of manufacturing. For when such changes are made, and one or more operations are eliminated, the effect on prices is entirely governed by the information that pertains to such work eliminated as specified on the Instruction Sheet. Thus changes and their full value are known to both workman and company. Such allows the company's immediate advantage of a change, and in no way affects the earnings of the men or violates the terms of the contract. After a change has been decided upon and carried out, all affected operations on the Instruction Sheet are ruled out by a red line, and a notice inserted

on the same line:-"Decision No. so and so". The company thus eliminates paying for the canceled operations, and the men do not perform those operations and maintain their earnings by producing more plow bottoms per day. This has proven a most excellent system, and one that has now been in operation for going on three years. For the benefit of those readers who wish to know more concerning the Decision system as installed by the writer in connection with the piece work system herein described, I have inserted a brief of the same at the end of this paper, and the forms used.

This system of Instruction Sheets for the use of the workman has not been carried out in any other department for the reason that the expense and time necessary for such has not been warranted, due to the reason we have not been compelled to meet any such conditions in other departments as existed in the fitting department. However, in order to readjust prices affected by change in methods of manufacturing such adjustment is regulated by reference to the original timing investigation sheet, (plate 5). These sheets being classified, indexed and filed away in a cabinet for that purpose.

The ultimate effect of the investigation of the Fitting department and in conducting the reorganization to meet the conditions as herein set forth resulted in placing the company in an independent position and the convincing of the old fitters that regardless of their services plow bottoms would be built in the way and at the prices determined by the elementary timing investigation. The men fully realized this and at the beginning of the following manufacturing season, the new organization was accepted with no trouble whatever, and today the men are earning on an average 12% more than they ever earned, and doing better work, and are better satisfied,

and the company in turn is securing a good day's work for a good day's pay. And thus the old adage that "right makes might" was proven again.

As regards calculation of prices for fitting department let

$2.88 - Piece work rate. This is the average of fitters rate (30/ per hour) and helper($27\frac{1}{2}$)

T - Total detail time per plow bottom, or total actual time necessary to do the work itself.

.43 - % of T for all necessary delays of the complete time.

x - price per plow bottom.

The formula

$$\frac{600}{T \times 1.43} \times x = 2.88$$

is self evident, where 600 represents the total working day in minutes. By transposing and reducing we get

$$x = .0048 \times 1.43\,T$$

To facilitate calculations of prices the curve of price and time for fitting plow bottoms was constructed. This curve was plotted on 18 x 26" co-ordinate paper, a photo of which is shown on plate 7. The curve serves a ready, accurate and quick means for such calculations.

A discussion of % of time for delays will be treated later in this paper.

In establishing prices for manufacturing work, one of the most apparently difficult problems is the requirement that prices shall meet all conditions. For illustration, if a workman received orders to build one plow bottom his earnings per unit time would and could not equal those when filling an order say for 100 bottoms, the price

being the same in each case. For it is a fact that changing from one job to another results in loss of time. A change always involves different tools, jigs, dies, etc., different materials and supplies and involves loss due to requirement of the workman to familiarize himself with the change of work or jobs. The writer's first attempt to meet such conditions was developed in the fitting department. The attempt has proven successful, and the method as developed for this line of work can be applied to all bench and erecting work.

As noted on Instruction Sheet, plate 6, two prices will be observed; one for the conditions that order twenty-five or more bottoms for the fitter to construct, and the other for twenty-four or less bottoms. The determination of these prices was by the timing investigation system. The resulting date, calculations, conclusions and allowable delays of such on investigation are as follows: The price for twenty-four or less bottoms was determined by assuming that the fitters would average the construction of twelve bottoms for such orders.

	3	minutes-	to change from one job to another.
	5	"	to get instruction sheet, gages, jigs, etc. from check room.
	5	"	to study instruction sheet.
	24	"	to get supplies.
	5	"	to sort out numbered parts.
	3	"	to familiarize with job. (Equals 10% of 30, the assumed average time to regularly complete one bottom.
Total	45	"	per bottom per change.

There fore for twelve bottoms delay, $\frac{45}{12}$ = 3.75' per bottom.

For 25 bottoms delay $\frac{45}{25}$ = 1.80' per bottom.

Per cent Difference.

Difference:- 3.75 - 1.80 = 1.95 let equal 2': let x equal value of the difference. Hence this formula is evident.

$$\frac{600}{2} \times x = 2.88$$
$$x = .92 ¢$$

Ass ume price of bottom at 20 ¢ for order of 25 or more. Therefore for 24 or less price per bottom will equal 20.00 - .92 = 20.92

or $\frac{20.92 - 20.00}{20.00}$ = 4.6% let equal 5% difference.

It is true that by the use of only the two classes of prices established to meet all conditions, the workman may not be able to average the same earnings per unit of time during the day for all conditions; however, he can and will maintain his weekly earnings, which is sufficient for all practical purposes.

In departments where changes of work or jobs are of frequent occasion, and such changes involve considerable time, and are a variable quantity due to changing and setting up of dies, gages, etc., each change has a piece work price in the same way that the work itself. Such a system is particularly well adapted to such work as punch and shear and forge shop work, for the work is of such a nature and variety that men may be required to make several changes during the day. However, the system of separate prices for work and changes will and does enable the men to earn their piece work rate regardless of the number of changes ordered during the day's run, or in other words earn the same rate if but one piece, say, is forged in certain dies as if one thousand pieces were forged. This is a new system for taking care of conditions just set forth. At least

I have never heard or come in contact with such. It is the general custom with the management of the shop practice to include the cost or time of changing in the piece work price of the article itself or pay the workman for such changes or a certain number of them his day work rate; all of which are indeed very unsatisfactory, and unfair, for under such conditions there will be more or less controversies between foreman and men, the one demanding changes to fulfil rush orders, the other reluctantly acceding to such demands on account of interference with earnings.

The method of applying this system of prices for changes to punch and shear work will be treated in another portion of this paper. However, the results of such an application are shown by photograph of the prices determined on plate 4.

The determination of the complete time for a job calls forth good judgment and sufficient shop experience in order to properly determine what shall constitute a good day's work. It is necessary that the one whose duty it is to determine piece work prices to know the limit of physical endurance and the influence of environments. The writer has gained the best of results by the following procedure The timer notes and times all elements of the complete time, whether unnecessary or necessary for each class of work. He stays with the man or men that are performing the class of work under investigation every minute of the working day. During this timing process the men are generally allowed to work at their regular pace, for the reason-after the system herein described is well established in a plant that all elements of the Detail Time can generally be analyzed, compared with, and corrected to conform to like elements of work already proven by their successful operation. The data concerning

the elements of the Complete Time are thoroughly studied, unnecessary delays eliminated, rest periods properly adjusted, uncalled for delays remedied by proper department management, and all elements made to compare with and be consistent with, all past and new prices established. The correct time of the elements of Complete Time, the known per cent delays of this are easily determined by dividing the sum by 600--the total number of minutes per working day of ten hours. This percent is the percent of the Complete Time for all necessary delays attendant upon the work itself. Now it is evident that the Detail Time has to bear and pay the corresponding labor cost of such delays, this can be expressed analytically.

Let y = Detail Time

x = Complete Time.

z = % of Complete Time for delays

Therefore $x - z \times x = y$

or $x(1-Z) = y$

y and z are determined by timing investigation and final proper adjustment, the value of x is determined by above formula and is one of the direct factors in the piece work price of a job.

As regards proper percent delays of Complete Time, the final and proper determination for one factory would not apply to another due to the many conditions that are influencing factors upon the same, and not only shop conditions, but geographical location as well. This percent varies at Deere & Co. from 10 to 40% of Complete Time for necessary delays. Rest periods from 35 to 120 minutes per day. Following are noted two concrete cases that are in actual use, and which will show the process of analyzing and determining the elements of Complete Time.

Elements of Complete Time or necessary and allowable delays attendant Bending Axles in Bulldozer.

Class--Axles requiring both hand and machine bending .

Description of Elements.	Time.
Starting up in the morning includes time required to heat furnace and stock; to get and arrange trucks, change clothes and all other preparation details	15' 00"
Starting up in afternoon, same elements as morning start up; time required by furnace to heat is less due to less lapse of time in using furnace.	12' 00"
Rest and toilet periods-morning	40' 00"
Rest and toilet periods- afternoon	40' 00"
Checking work with pattern	9' 00"
Miscellaneous delays includes receiving orders and instructions from foreman, truck and material delays	6' 00"
Maintaining machine includes tightening bolts, oiling, etc.	5' 00"
Maintaining furnace includes adjusting burners	5' 00"
Quitting at end of morning	8' 00"
Quitting at end of afternoon includes making out time slip	10' 00"
Total	150' 00"

Or $\frac{150}{600}$ = 25% of Complete Time for unnecessary delays.

Necessary and allowable delays attendant Bradley Hammer Work--Medium Weight Work that is run in heats.

Starting up in the morning------------------------------20' 00"
Starting up in the afternoon----------------------------15' 00"
Rest period in middle of morning------------------------20' 00"
Rest period in middle of afternoon----------------------20' 00"
Maintaining dies-- 6' 00"
Maintaining machine------------------------------------- 8' 00"
Miscellaneous delays------------------------------------ 6' 00"
Quitting at end of morning------------------------------10' 00"
Quitting at end of afternoon----------------------------10'00"
115' 00"

Sum of rest intervals during runs of 15' duration, 5' per rest interval $\left(\frac{600 - 115}{20} \text{ X } 5\right)$--------121'
236'

Or $\frac{235}{600}$ = 39 1/3% let - 40% of Complete Time for necessary delays.

The relation between piece work rate andday rate rate is generally not specific in plants operated by the piece work system, for the reason under such conditions the men so seldom have day work that the subject has never been pressed or forced to an issue. However, it is advisable to have all day rates uniform and consistent, so that when new men start in at a day rate that is consistent with the established rates, they will be able to earn a fair wage until such a time that they are sufficiently familiar with the work to perform it on a piece work basis. Again, it is well to maintain as great a difference between piece work rates and day work rates as it is possible to do so; such an arrangement will act as an incentive

to the men in performing their work--piece work, and instead of the company continually forcing the operation of the system the men will demand the same. For the benefit of my readers who may be interested in the pervailing day rates of wage earners, I herewith insert such information as compiled by the Bureau of National Cash Register Co. of Dayton, Ohio.

HIGHEST, LOWEST AND AVERAGE HOURLY RATE.

	Highest	Lowest	Average.
Lathe hands-best	.365	.18	.276
Lathe hands-ordinary	.305	.15	.228
Screw machine hands			
Automatic	.333	.107	.231
Hand	.305	.10	.209
Milling Machine hands	.30	.083	.207
Drill Press hands	.25	.088	.18
Vise and Bench hands	.337	.15	.245
Assemblers	.325	.15	.214
Machinist Helpers	.224	.125	.166
Laborors	.195	.125	.159
Truckers	.20	.125	.161
Packers	.25	.114	.181
Stock keepers and Gauges	.265	.15	.196
Toolmakers	.395	.222	.298
Punch Press hands	.25	.085	.183
Buffers and Polishers	.40	.10	.232
Pattern makers - wood	.415	.225	.313
Pattern makers - metal	.375	.225	.294
Blacksmiths	.375	.20	.274
Blacksmiths helpers	.24	.15	.297
Tool Dressers	.45	.205	.243
Moulders			
Brass	.332	.225	.246
Iron	.46	.225	.289
Moulders helpers	.20	.137	.161
Carpenter	.35	.20	.241
Cabinet makers	.30	.175	.253
Cutters	.275	.20	.23
Stickers	.275	.15	.21
Universal Woodworkers	.262	.159	.209
Band and resaws	.275	.135	.218
Friezers and Shapers	.275	.20	.241
Planers	.262	.15	.209
Sanders	.25	.15	.195
Millwrights	.40	.175	.269
Engineers	.265	.20	.254
Fireman	.275	.15	.187

The Piece Work System Applied to Drilling.

In a large manufacturing plant the question of drilling is a rather important one. The amount of drilling done is sufficient to warrant a very careful investigation, and the saving secured is a rich return for the time and effort spent in the investigation.

In the fall of 1904 it was decided to make an investigation of drilling as done at Deere and Co.'s shops in Moline, and establish a correct system of prices. We began in the Fitting department in whcih there are about ten drillers. A large part of the work comes in comparatively small lots, and is, in consequence, changed around more or less, so that each man has not a particular line of work, but the same work goes to different men at different times.

In this work, as all other, consistency of prices throughout is of the highest importance, both because of its advantage to the company and in justice to the men.

An added difficulty presents itself, in the case of drilling, as compared with other work, due to the fact that drilling is usually done in several departments of a plant under different conditions as regards speed of drills, kind of drill presses, and arrangement of work.

About six weeks were spent in the Fitting Department timing the work. At the end of that time a thorough study of the data taken was made. At first glance great discrepancies showed up and on further comparison of different kinds of work and observations of different men on the same work, these appeared so numerous and large as to cast a shadow of doubt over all that had been done.

The time for handling may be determined, relying upon judgment to decide whether or not the man is doing the work at fair speed

and whether he is doing any unnecessary work, or not doing it in the best way. When, however, we come down to the time for drilling, the actual time that the drill is in the stock, one's judgment fails There is nothing that we can see to inform us when the man is not drilling at a proper speed, that is, forcing the drill through as fast as it should go. Again a driller may sharpen his drills better than another. In short, one driller may drill very well, due to being timed, and another may drill more slowly for the purpose of deception or lack of proper knowledge how to use both machine and tools, and the timer is unable to detect all such discrepancies by anything that can be seen.

In view of these difficulties, we decided to conduct a series of tests to determine, first, the proper number of revolutions for different size drills in different kinds of stock. Second, the quickest time in which the different size holes can be drilled in different kinds of stock, durability of drill being considered. Third, number of inches of stock that can be drilled without sharpening drill, at the above speeds, in the different materials.

In carrying out these tests we first took the best regular driller at our command and tried drilling at different speeds of the drill and in different times. It soon developed that this would not give us the results that we desired for there was no uniformity in the times that we could get from his drilling. A foreman was tried next. This man was an expert driller, and knew what we wanted and was perfectly willing to do his best. After trying him for a day or two, however, we were not much better off than before. At this stage of the work we concluded that we could not get accurate results from observations of any regular driller, no matter how expert

and conscientious the man may be; and decided to see what we could do for ourselves. The results simply offer another proof of the old adage "If you want a thing well done, do it yourself."

The materials used in the tests were soft bessemer steel, hard open hearth steel (40 to 50 carbon), malleable iron, hard grey iron, soft grey iron and wrought iron. To these was added later by a similar series of tests, hard bessemer steel (54 carbon.)

Soap water was used for lubrication. This was run from a tank set on a table above the drill, through an ordinary gas pipe, with a nozzle on the end, and this stream controlled by a cock, played upon the drill continuously druing the drilling. The soap water is made as follows:- eight dipper fulls (12½ quarts) of Viscosity Cutting Compound (made by the Cataract Refining & Manufacturing Co., Buffalo, N. Y.) are put in a tank of 170 gallons capacity, and three pail fulls of hot water are thrown on it; this is stirred until the compound is dissolved, and then the tank is filled with cold water and is ready for use.

Whitman & Barnes drills were used, and both foot and hand lever drills. Although in some classes of work, there is some difference in the time for handling, when foot and hand lever drill presses are used, there is no difference in the actual time required to drill the holes. However, for test purposes, the hand lever drill is more satisfactory because it allows more accurate control of the time of drilling the holes.

The sizes of the holes drilled ran from 1/8" to 11/16" and included the following 1/8", 3/16", 1/4", 5/16", 11/32", 13/32", 15/32", 17/32", 9/16" and 11/16". The intention at first was to run all the tests on 1/4" stock, but by means described hereafter,

differences due to difference of thickness of stock, are taken care of.

Our immediate object was to determine the time to drill per 1/16" of stock drilled for the different size of holes in the different kinds of stock, always bearing in mind the durability of the drill. We fixed 100 holes as the number to expect from all sizes of drills in soft bessemer steel, wrought iron, soft grey iron, and malleable, and 50 as the number to require of all sizes in hard open hearth and hard bessemer steel, and hard grey iron.

We proceeded to determine the time per 1/16" thickness of stock drilled, and although at first the results obtained, even when drilling ourselves were far from consistent, by repeated trials, we finally got a series of points sufficiently regular to enable us to plot curves, as shown on plate 9.

The shape of the curves is a regular increase of time per 1/16" from 3/16" drill up, but below the time is more. If all sizes of drills were proportional in strength and stiffness, the curves should be practically straight lines. However, this proportion seems not to exist, for, as we come down the curves the drills become weaker and more care is required to prevent breaking. This shows itself by the gradual bending of the curve away from a straight line, tangent at the upper end of the curve and the bending away is increased gradually, until at the point representing the 1/8" drill, we find that the curve has bent around so that we have more time required to drill per 1/16" of stock for the 1/8" drill than for the 3/16" drill.

Having obtained the curves-one for each kind of stock-we went back and repeated all of our work, to prove absolutely that the re-

quired number of holes could be drilled with one drill without sharpening, in the exact time figured from the curves. This proven, we were satisfied that our curves were correct for the work they represented.

When measuring the stock drilled and computing the time required and comparing this with what we had observed in the actual work of the Fitting Department, our results corresponded with the best of the observed times in cases where the stock drilled was approximately the same thickness as that drilled for the curves.

When, however, the stock was much thicker than that used in obtaining data for the curves, we found a few cases where our observed times were considerably less than the computed times. This we were finally able to explain as follows:- The point of the drill is conical. When the drill is started, the whole of the cutting edge does not begin to cut at once, and at the breaking through, the point ceases to cut while the heel is still cutting its way through. In other words, in drilling 1/4" stock, for example, the drill is cutting continuously while it moves through a vertical distance greater than 1/4" by the height of the cone of the point of the drill. This increase is the same for all thickness of stock. Hence the thicker the stock, the less per 1/16" this addition would be.

Now to ascertain the amount of allowance to be made for this; the larger the drill, the larger the height of the cone of the point (the angle of the point being the same). This at first sight would lead to the conclusion that a different allowance would have to be made for each size of drill. Here another consideration comes in. The larger the drill, the less likelihood of breaking the drill in breaking through the metal, hence the less care required in coming

through. It was found that this time lost in breaking through so combined with the time for the extra distance, that by counting the time for these two losses as 3.7/16" additional to the same stock, we got correct results throughout. This was determined by further tests on different thicknesses of metals, and when with this revision we applied our curves to the cases which before had puzzled us, the results were very close.

Using the additional 3.7/16" of stock allowed, making in drilling 1/4" stock 7.7/16" and in 3/4" stock 15.7/16" we computed the curves seen in the upper left hand corner of the chart which gives us the percent of the computed time, to be used for different thickness of stock. Thus to drill a 15/16" hole in 1/4" S. B. S. we simply take our 2.08" the time to drill per 1/16 " of stock, and multiply by 4, the number of sixteenths, and we get 8.32". For 1/2" stock, 2.08 x 8 x .76 (our percent of computed time to be used) equal 12.65". For 3/4" stock, 2.08 x 12 x .68 - 16.97".

Prices figured from these curves have now been in use over a year, and have proven extremely accurate, the only failures of correct results being due to unusual differences in the hardness of stock.

As explained on the chart, the straight line curves in the lower portion give us the time to be allowed for changing and grinding drills. In determining these, we first made the allowance for changing drills, one per 371/2" of stock, once per 25" of stock, or once per 12 1/2" of stock, according as it was for malleable, soft or hard stock. The grinding we got from experiments and found that the time to grind a single drill was practically proportional to the diameter of the drill. Laying out a point to represent the

allowance to change drills, its proper distance along the original base line and from this point as an origin laying out our points representing the allowance made for grinding, and drawing in the curves for the different materials, we have by these additions the time to change and to grind drills. These are based on the number of inches of the material drilled and reduced to time per 1/16" of stock.

The percents for rest and delays were determined in the usual way by observations taken directly in the shop covering complete days, four days in all. The delays noted on the chart are constant delays, and that percent (8.3% of the complete time) is used in all drilling work. Besides the 9%, a second percent varying from 9% to 13% of the detail time is figured in. This second percent includes all necessary delays not included in the constant delays, and varies in different classes of work, and in different departments, due to different arrangements for doing the work.

It will be seen that with this chart we are in a position not only to figure consistent prices for actual drilling work quickly and accurately, but can also make very close estimates on any piece that is seen or even described. All that need be estimated is the handling, and this may be done very accurately by an experienced timer. This ability to estimate prices and costs of work on pieces not yet made is of no small importance in a manufacturing plant where new machines are constantly being made, for an accurate estimated cost of the same is very essential and is an important factor in maintaining the business as a profitable one.

As examples of the method of figuring prices by use of the chart, I will give the figures for a few actual jobs as figured and in use

First are the figures for the drilling of a frog or steel frame for a riding plow. This is made of 3/8" soft steel weighing about fifteen pounds, is drop forged to a shape having two irregular surfaces forming an angle of about 45 degrees with each other. The number and size of holes are given in the analysis. The piece is drilled by a jig fastened and held in position by two set screw clamps. All drill bushings are of the same size, thus eliminating the necessity of changing drills for each piece; holes to be drilled of different size than the bushings are marked only by the drill corresponding to the diameter of bushing.

Drill No. 12 Frogs, 3/8" soft steel.

Drill 4 13/32" hole	4 x 6 x 1.76 x .84 -	35.48"
Grind	4 x 6 x .47 -	11.28"
Handle and jig		19.00"
Bet. holes	3 x 2 -	6.00"
Mark 6 holes		12.00"
Drill 3 15/32" holes	3 x 6 x 2.08 x .84 -	31.45"
Grind	52 x 3 x 6 -	9.36"
Bet. holes	2 x 2 -	4.00"
Handle		6.00"
Drill 1 17/32" hole	6 x 2.45 x .84 -	12.38"
Grind	6 x .57 -	3.42"
Handle		6.00"
Drill 2 11/16" holes	2 x 6 x 3.55 x .84 -	35.78"
Grind	.7 x 2 x 6 -	8.40"
Handle		6.00"
Bet. holes		2.00
Counter-sink 5 holes		25.00"
Total detail time		233.55"
Complete time	(233.55 x 1.09) x 1.09 = 277.5"	
Price per 100 at 22 ½¢	$1.74	
Old price	$2.40	
Saving per 100	.66	

A steel landside 4" x 7/16" x 14" hard bessemer steel was figured as follows:-

Drill #3 Gang Landside. 7/16" H. B. S.

Drill 1-15/32" hole-----------7 x 2.95 x .84 - 17.35"

Grind------------------------------7 x 1045 - 7.32"

Handle-- 5.00"

Drill 1-17/32" hole-----------7 x 3.50 x .84 - 20.58"

Grind-------------------------------7 x 1.145- 8.02"

Handle-- 5.00"

Countersink 2 holes----------------------2 x 4- 8.00"

Handle-- 5.00"

Total Detail Time------------------------------76.27"

Complete Time------(76.27 x 1.09) x 1.09 = 90.62

Price per 100 at 22 1/2¢ ----------------- 57¢

Old price------------------------------------ 80¢

Saving per 100------------------------------ 23¢

The time for counter sinking in both of these cases was taken from observations.

The following are the figures for a price for drilling a 7/32" hole in 7/16" bolt stock.

Drill #4286. 7/16" O Bolt stock 7 3/4" long.

Drill 1-7/32" hole in 7/16" stock--7 x 1.1 x .84 - 6.47"

Handle--- 5.2 "

Get and count------------------------------------ 1.0 "

Set jig and arrange table of machine-------------- 1.0 "

Grind------------------------------------7 x .316 - 2.11"

Total detail time---------------------------------15.78"

Complete time---------(15.78 x 1.09) x 1.09=18.75"

Price per 100 at 22 1/2¢ ---------------12 ¢

It will be noticed that in small jobs that come in small quantities allowance is made for counting and also for setting jig when jig is fatened to table of machine.

Drilling a 13/32" hole in 1 1/8" O H. B. S. 8 1/2" long.

Drill #4676

1 1/8" O H. B. S.

Drill 1-13/32" hole---------18 x 2.5 x .63 - 28.35"

Grind------------------------------18 x .94 -16.92"

Get to table and count---------------------- 2.00"

Handle--------------------------------------- 5.00"

Total Detail Time----------------------------52.27"

Complete time-------(52.27 x 1.09) x 1.09 = 62.13"

Price per 100 at 22 1/2 ¢ = 34 ¢

These curves also apply to pipe.

Drill #1104. Pipe 1/4" soft pipe, 45" long.

Drilled on double hand lever drill. Held in jig by 3 set screws and drilled complete at one handling.

Drill 5-13/32" holes----------5 x 2 x 4 x 1.75 - 70"

Grind for " " -----------5 x 2 x 4 x .47 - 18.8 "

Bet. sides of pipe-----------------------5 x 1 - 5.0 "

Drill 2-11/16" holes---------2 x 2 x 4 x 3.55 - 56.8 "

Bet. sides of pipe ----------------------2 x 1 - 2.0 "

Grind for 2 11/16" holes--------2 x 2 x 4 x .7 - 11.2 "

Jig and handle-------------------------------------35.0 "

Bet. holes-11/16" holes------------------------- 5.0 "

Bet. holes 11/16" and 13/32" holes--------------- 6.0 "

Bet. holes 1st and 2nd 13/32 "------------------ 6.0 "

Bet holes 2nd and 3rd---------------------------- 5.0 "

Bet. holes, 3rd and 4th----------- --------------5.0 "

Bet. holes, 4th and 5th-------------------------- 6.0 "

Total Detail Time--------------------------------231.8 "

Complete time----------(231.8" x 1.09) x 1.09 = 275.4"

Price per 100 at 22 1/2 ¢ ---------$1.72

Old price-------------------------- 2.50

Saving per 100--------------------- .78

It will be noticed that the pipe is simply considered as two separate sections of 1/4" stock.

The method of applying this chart to the case of castings on bars or pipes is shown by the following example.

Drill #4522 Pipe.

1/4" pipe-Mall. F159 on end.

Drill 3/8" Mall. - 1/4" S. B. S.

Drill 2-3/8" holes (through pipe and 3/8" malleable on
each side of pipe)-----2 x 2 x 8 x 1.62 x .76 - 39.4"

Bet. sides of pipe---------------------------------- 2.0"

Grind for 3/8" holes-------------- 2 x 2 x 8 x .445 -14.2"

Drill 3-13/32" holes (pipe only)---3 x 2 x 4 x 1.75 -42.0"

Bet. sides of pipe------------------------------------ 3.0"

Grind for 13/32" holes-------------3 x 2 x 4 x .47 - 11.3"

Jig and handle---------------------------------------30.0"

Bet. 3/8" holes-------------------------------------- 5.0"

Bet. 3/8" and 13/32" holes--------------------------- 6.0"

Bet. 1st and 2nd 13/32" holes------------------------ 6.0"

Bet. 2nd and 3rd 13/32" holes------------------------ 5.0"

Total Detail time-----------------------------------163.9"

Complete time-------(163 .9" x 1.09) x 1.09 = 194.73"

Price per 100 at 22 1/2 ¢ ---------$1.21

Old price---------------------------1.50

Saving per 100--------------------- .29

It will be seen that in computing the time to drill a casting on a bar or pipe, it would have been incorrect to consider drilling through a certain thickness of casting and add the time figured for the bar or pipe alone, as this would allow the time for breaking through twice. For this reason, the drilling of the casting is reduced to an equivalent thickness of the same metal as the pipe or bar, and the time is computed for a hole through a thickness of this stock equal to the actual thickness of the pipe or bar plus the equivalent thickness of the casting.

All these prices are figured direct from a curve laid out by very simple calculations to give the price per 100 at any hourly piece work rate for any complete time; see plate 8.

In connection with this discussion of drilling, I wish to give an illustration showing results gained by the use of high speed steel, novo, in this case. This gain not due to increase of speed of cutting, but due to greater durability.

The economy of high speed steel drills was considered, but although no thorough and conclusive tests were made with these, their use did not appear advisable except in one case. This exception was found in the case of countersinking. With the ordinary five lip countersink for countersinking square holes in crucible cast steel shares, it was found that 75% of the detail time in the case of 1/2" holes and 20% of the detail time for smaller holes, was required for sharpening. With the "Novo" steel countersink this was reduced to 9% for 1/2" holes and 5.4% for smaller holes. Thus the use of the "Novo" steel countersinks resulted in a large saving, but all the saving as a result of reduction of time for sharpening. We were not able to do the actual work any faster with this tool than with the

ordinary tool steel countersinks.

Some of the prices figured for these two tools are given below:

	Cresecent tool steel.	Novo
Countersink share with 1-1/2" hole	13 ¢	8 ¢
" " " " & 1-7/16"	17 1/2 ¢	17 1/2¢
" " " " & 2- "	22 ¢	15 1/2¢
" " " 3 - 7/16"	16 ¢	14 ¢

Men will often contend that the work cannot be done as figured; that they cannot make the wages that are expected of them. In such cases after a reasonable trial by the man himself, we undertake to show the man that it can be done. We will stay with him a full day if necessary, so as to prove the correctness of the price beyond a doubt. First we give him the pace at which to drill, if necessary drilling a few holes for him and showing him by the watch just how long we took. Starting him in again, we show him the time that he takes for the same work, and insist and prove that he can come up to our pace. Next we see whether or not he is handling the pieces with the proper speed. We inspect the drills to make certain that he is sharpening them so as to get the best results. The delays are observed and if in any way he loses time to such an extent that he does not earn his piece work rate, we are able by close observation to detect the trouble and apply the remedy. Such cases, when the man after being directed does not make good the first day, are extermely rare.

A man who once gets the pace on a few jobs does not usually have any difficulty with any that he takes up afterward, so that it does not take long to get the men educated so that they are able to take up new jobs and turn out the required amount of work without any

help from us. As another means of educating the men we have posted a schedule of the correct speeds to use for the various sizes of drills for the different materials.

Sometimes stock of unusual hardness is received which is impossible to drill as figured. To meet this condition the foremen are instructed to make a proper estimated allowance by allowing day work. It would hardly be practical to have a scale of prices that would cover all conditions of variations of steel grades in agricultural implement manufacture, due to the extensive use of old rail stock.

The following is a comparison of the results of our tests with the speeds and time per 1" of soft grey iron as given in Kent's Mechanical Engineers' Pocket Book.

Speeds	From Kent	From tests.
1/8" up to and including 1/2"	660 to 160	420
17/32" " " " "	150 to 105	220

We had a slower speed of 110 revolutions per minute, but this was not used.

Time per 1" of soft grey iron.

	From Kent	From tests.
1/4"	23.43"	12.04"
1/2"	45.00"	22.97"
3/4"	57.3 "	41.24"

Revolutions per 1" solft grey iron Drilled.

	From Kent	From tests.
1/4"	125	84.3"
1/2"	120	160.8"
3/4"	100	151.2"

The durability of drills when operated at the speeds determined by tests and as indicated by the chart is shown by the following information. This durability is the average number of linear inches that the drill will perform for one sharpening.

Material	No. of inches.
Soft grey iron	25
Soft Bessemer Steel	25
Hard " "	13 1/8
Hard open hearth steel	12 1/2
Malleable	37 1/2
Wrought iron	25

PUNCH AND SHEAR WORK.

The punch and shear department was turned over to the rate fixing department the fall of 1904; not so much for the purpose of reducing labor cost as for the purpose of reorganization. Such a program was made absolutely necessary, due to the confusion that existed in this department which resulted in this department limiting the output of the whole plant. The following description of the application of the piece work system to this line of work, and the ways and means ~~that~~ by which the original investigation and final operation were conducted, will further illustrate the close association and intimate relation of methods and prices. The employer, the superintendent and the student should never neglect the importance of associating these two lines of work, one following the other in all cases. This, as has been previously stated, in order to realize the full benefits and results of a change .

The reorganization and installation of correct piece work prices resulted in several thousand dollars saving per year, and the making of the department as efficient as our best organized one.

At the time the department was assumed by the writer, the foreman was discharged for many good and valid reasons, and the writer assumed entire charge of the department assisted by Mr. Stone. In this way we were put into immediate and close touch with the work, the details of the needs and requirements of the department and were thus enabled to make a thorough study of the situation.

The first move made toward reorganization was to establish dis-

cipline, which was indeed a negative quantity. This was done slowly but firmly and best accomplished by introducing new and experienced men from other plow manufactories, thus establishing competition for the work, and in all cases the successful bidder being the best man. After discipline was established and a comparatively efficient force organized, the elementary timing of work and investigation was begun.

When the investigation for establishing prices of this department was commenced, a large part of the gang punching and a small part of the single punching was piece work. All the rest of this work and all cutting and trimming was day work. The piece work prices in use at that time were high; however, these served to set a better pace for the men than the day work. As regards cutting and trimming, the workmen were so slow that it was extremely difficult to get any idea of what could be done, as a result of available information being based upon such conditions.

All the work of the department was observed very carefully, and timed in the usual manner, with such variations as the class of work required. A large part of this work is done with the machine running continuously and the time per revolution of the different machines was taken and tabulated. See plate 10. We decided that there would be no gain in trying to speed up these machines, and used the times per revolution as a basis for figuring all work with the machine running continuously, always for any class of work taking the time of the slowest machine on this class of work.

Before the investigation had progressed to any extent, it became evident that a correct allowance for trucking on all jobs was very important, as in many cases this made up a very considerable part of

the time for the work. Our thought and observations resulted in the accompanying curves for trucking under various conditions. See plate 11.

The explanations on the chart will help to make these curves clear. It will be seen that all the times for trucking are found from these curves in terms of seconds per bar. The hyperbolic curves running from the upper right hand corner to the lower left hand corner of the chart, show the number of bars, on the lower scale, of any cross section as traced from the vertical scale on the left hand side that will usually be put on either style of truck. For the lower curve the inner scale on the left is used and the lower scale is multiplied by ten. These are figured on a basis of 3500 pounds as a load. For small trucks 2500 pounds was taken as an average load and for two wheeled carts 1250 pounds. From these curves it was a simple matter to figure the time per bar for all sizes of stock under the different conditions after determining by observation the time required to move and replace each kind of truck. Curves were laid out to give the time per bar when stock was taken from a large truck and put on a small truck; also when put on a two wheeled cart. Later additions to this chart were made to cover other conditions of taking stock from small truck to small truck, and from two wheeled cart to cart. A second trucking curve, see plate 12, was laid out to give the trucking in seconds, per piece from the weight of the piece, when taken from small truck to small truck. There was a great deal of work for which the curve in this form was more convenient. Again this curve is used almost universally for all forge department work.

The time for trucking is not an absolutely definite factor, for

the men will use different styles of trucks for the same work at different times, but by choosing the most probable method of handling any given piece and then applying the curves, we were safe to assume that most conditions of handling stock would be properly met. The time allowed for changing trucks is 2' 00" for large trucks, and 1' 30" for small trucks. This is generous for the change is usually made in less time, but when part loads are considered, this is as it should be. Prices figured on this basis for trucking, have proved very adequate.

Work in a shop of this kind where all old lines of goods are made along with standard machines, is of necessity very irregular as regards the number of pieces of a kind made at one time. In some work a man may work for days at a time without a change, and at other times he will literally put in a whole day changing and do only enough work to make a small fraction of his day's wages at any reasonable prices. In view of this fact, a new idea was put into practice in the shape of piece work prices for changes. At the time that the gang punching dies were indexed, we had the men set up all of these dies just as if they were going ahead to do the work. This was done in order to make sure that all necessary bolts, gages, etc., were at hand. At the same time, we tried these changes, and from the times observed, figured piece work prices for all possible changes on gang punches. Each price for a change paid for the setting up and tearing out after that job. See plate 4. The same system was carried out for single punching and shearing. For single punching the prices were figured from the efficient times observed during the regular work. The elements of this time are as follows:-

Change trucks and arrange around machine----------3' 00"

Check work--1' 30"

Get patterns--------------------------------------2' 00"

Set gages (1 hole)--------------------------------3' 00"

Change punches------------------------------------8' 00"

Total Detail Time--------------------------------17' 30"

Complete Time------------------------------------21' 00"

Price at 30 ¢ = 10.5 ¢ let = 11 ¢

Add 3' to the above for each hole over one that is gaged.

This 3 minutes = 1.80 ¢ See table on plate 4.

For all changes the total detail times are all increased 20% to include the elements of the Complete Time such as rest and delays beyond the control of the workmen.

For changing knives the price 12¢ was figured based upon time taken from the average of a series of changes made by the new foreman. The price for changing jobs, 6¢ in most cases, was determined from observations of actual efficient changes during work, and includes changing gage, checking set of gage, and all other delays incidental to a change.

In the case of both single punching and shearing, men have put in time slips with from 25¢ to 50¢ for actual work, and the rest of their time was devoted to changes. However, under these extreme conditions, the men have been able to maintain their piece work rate and in return, the company has been a beneficiary as well, by receiving good and efficient work.

Gang punching is divided first into two classes, that done on the small or regular size machines, and that done on the six and nine foot presses. The former was figured on a basis of 30¢ per hour to the machine man and the latter at 35¢ per hour.

The work on the small machines divides itself into two classes, namely punching from bar stock, and gang punching pieces cut to length or dimension stock, the latter class including various special jobs such as blanking and bending, as well as straight punching.

All work punching from bar stock, was figured for the work to be done with a boy as helper to "shove bars". Oiling punches and maintenance of tools was assumed constant. A constant allowance of 11" between bars was made for the boy to get the next bar ready and for the man to oil punches and clean away slugs and trimmings. The time during bars was taken as the time for the necessary number of strokes, increased by a percent to cover all delays such as pieces sticking in dies, or slugs or trimmings interfering. This percent was taken as 5% of the time during the bar for ordinary pieces, that is, pieces between five inches and thirty inches long.

For pieces under five inches in length the percent had to be increased because the pieces had to be removed from the dies with a hook, and this was not as quick as when the piece could be handled by hand. Ten percent was allowed for pieces under five inches long. In the case of pieces over thirty inches long the boy has to be quick to get the bar into position for the next stroke, and if he does not succeed in doing this, the machine man must stop the machine. For such delays on pieces over thirty inches in length 20% of the time during bars was allowed. The following will serve to illustrate the method of figuring these prices.

Punched stock 5" to 30" long.

8 pieces per bar.

	Strokes		Time of one stroke.		% added	
Time during bar	9	x	1.94	x	1.05	- 18.33"
Bet. bars--						-- 11.00"
Trucking---						3.2 "
						32.53

Total Detail Time--- $\frac{32.53}{8}$ ------------------------------- 4.07

Complete time - 4.07 x 1.293 (% for rest and delay) ------- 5.26

Price per 100 at 30¢ from curves - 4½¢

Pieces over 30" long.

3 pieces per bar.

Time during bar------------------- 4 x 1.94 x 1.20---9.312"

Bet. bars-- ----11.00

Trucking--- 3.2

23.512

Total Detail Time--- $\frac{23.51}{3}$ --------------------------- 7.837

Complete Time--- 7.837 x 1.293------------------------10.133

Price per 100 at 30¢ from curves-----8½¢

Pieces under 5" long.

37 pieces per bar.

Time during bar-------------38 x 1.94 x 1.1-----------81.1"

Bet. bars---11.0"

Trucking per bar from curve----------- --------------- 3.2"

95.3"

Total Detail Time------$\frac{95.3}{37}$ ------------------------ 2.58"

Complete time----2.58 x 1.293------------------------ 3.3359"

Price per 100 at 30¢ from price curves----2 ¾¢.

This was taken as a flat price for all pieces under five inches long.

These prices were figured with an allowance of 1.94" per stroke which is the time required for one stroke of machine #425, the slowest of the machines at which this class of work was done. The 29.3% added to cover time for rest, machine maintenance and all other necessary delays, was determined by observing different men for whole days at a time and keeping an accurate record of all the time not spent in actual work. The results of these observations were compared and were gone over very carefully to decide how much of each item was necessary. The resulting table of delays is given below.

Gang Punching Delays.

Rest and toilet	60 00"
Oil and clean machine	7 00"
Empty slugs and clean up around machine	8 00"
Let roustabout clean up	3 00"
Check setting of dies and gages	2 00"
Take out and replace broken punches	20 00"
Count bars, figure, report, and route truck	20 00"
Outside delays--talking, receiving orders, helping others, delayed by trucking not his own	10 00"
Make out time slip	6 00"
	136'00"

%Detail time for necessary delays---$\frac{136}{600-136}$ - -----29.3%

It was found that these delays would be constant for practically all gang punching. For very rough work such as pressing, the machine and tool maintenance was less and a second series of delays, given below, was allowed for this work.

Delays for rough gang punching work such as crimping, pressing, etc.

Rest and toilet-----------------------------60' 00"

Oil (5) and clean (2) machines---------- 7' 00"

Clean and let roustabout celan around machine------------------ 5' 00"

Outside delays, talking, etc.------------10' 00"

Make out time slip----------------------- 6' 00"

88' 00"

% of Detail time for necessary delays

$\frac{88}{600-88}$ ----------------------17.2

To apply the prices as figured above to any particular piece, it was only necessary to get the length of the piece and the length of the bars from which it is cut, and the number of pieces in a bar.

This series of calculations gave a perfectly consistent series of prices and there was no chance for any discrepancies in the prices of the work of this class as done by different men on different machines.

Curves, shown on plate 13, which were used in determining the prices for punching cultivator beam stock-, will serve to illustrate the general methods of calculating prices on this class of dimension stock. This stock had to be considered separately for the holes are punched in the web adjacent to the bead. This results in extra time being consumed in removing the punched stock from the machine when the dies are the least bit dull.

To figure a price on this class of work from these curves, first determine the method of handling the piece; second, measure the length. The time is then accurately given by use of the proper curve. Add trucking time and percent for rest and delays in the usual way. The Complete time known,the price is readily determined by curves on plate 8.

Naturally the fastest way to handle the stock is to take hold with the whole hand in the center of the piece. Handling it by the fingers at the ends of the piece is faster than when the stripper so covers the piece that it has to be removed from the dies with a hook. The position of the holes in a piece and the length of the strippers determine the method of handling.

From the observations and data on single punching, prices were figured as shown by the curves given and explained below. It was decided to figure all single punching both with and without a helper, the helpers being boys and unreliable, and not always available, made this necessary. Further, for all ordinary work with the machine running continuously, the price per stroke was figured to which was added an allowance for each handling to cover trucking and handling. This allowance was based on the weight of the piece. Thus a scale of prices was established that included the greater part of single punching and the attendant conditions.

The allowance per stroke is as follows:-

Per stroke, (time of slowest machine)-------- 2"

5% added for oiling punches & strokes missed

2" x 1.05---------------------2.1"

Complete time---2.1 x 1.255(% for rest and

delays------------------------2.6322

Price per 100 at 30¢ from curves- 2.2¢ per stroke.

This percent for rest and delays was determined exactly as for gang punching, and the individual items are given below.

Single Punch Delays.

Rest and toilet----------------------------60'00"

Oil (5) and clean (2) machines---------- 7'00"

Empty slugs and clean around machine---- 8'00"

Let roustabout clean up----------------- 3'00"

Check work------------------------------ 6'00"

Grind punches--------------------------- 3'00"

Replace broken punches, 6 times 2'3" ---15'00"

Mark truck and keep track of pieces, not counting---------------------------- 4'00"

Outside delays, talking, receiving orders, helping others, trucking not his own,-10'00"

Make out time slip---------------------- 6'00"

% of Detail time for necessary delays, $\frac{122}{600-122}$ -------25.5

Considering that a separate price will be given for changing jobs and changing punches.

Count pieces and get to tale is included in the detail time.

Curve, plate 14, was determined directly from data and curve,-plate 15, was simply made out to give the time for trucking and to add this to the time from curve, plate 14, to get the work to table and count. When the man works with a helper, the allowance over the price per stroke simply coveres the trucking. When he has no helper, the allowance includes time to pile on a table by his machine and count. To get this time was the object of curves plate 14 and 15, and they give the time for the different weights of pieces. Table on plate 16 gives the deductions from these curves and this table is used for all ordinary single punching with the machine

moving continuously.

After we had established this scale we went over all of the patterns and with the aid of the foreman, who is himself an expert punch-man, determined the number of handlings and the number of strokes for each piece, and figured the prices for all, both with and without a helper.

As an example of the way these were figured, let us assume a piece weighing 3½ pounds with two different sizes of holes, and requiring six strokes to punch and handle. The piece would be--

6 x 2.2 - 13.2
2 x .37 - .74
13.94 - 14¢ with helper.
6 x 2.2 - 13.2
2 x 2.1 - 4.2
17.4 - 17½¢ without helper.

The old scale of prices was based on 3¼¢ per 100 strokes with a helper, which corresponded to our price of 2¼¢ for pieces weighing under two pounds and 2½¢ for jobs under four pounds.

Shearing.

All cutting from bar stock divides itself into two classes, cutting with machine running and cutting with machine stopped between cuts. The first determination made to figure this work was the number of bars to be handled at a time for cutting, and the second was to determine the length of the longest pieces that could be cut handling this number of bars, catching strokes of the machine. It is true that fewer bars could be shoved to cut longer pieces, catching strokes, but this would result in loss rather than gain. The results of our investigations on these points are given

below in table.

Stock	No. bars handled at once.	Handle Strokes	Handle Time	Longest possible shove
1/4"0	6	17	34"	40"
5/16"0	6	17	34"	40"
3/8"0	5	15	30"	40"
7/16"0	4	13	26"	40"
1/2"0	4	13	26"	40"
3/16"0	3	10	20"	40"
5/8"0	3	10	20"	40"
3/4"0	2	7	14"	45'
7/8"0	1	4	8"	54"
1"0	1	4	8"	54"
1 1/8"0	1	5	10"	54"
1 1/4"0	1	6	12"	48"
1 3/8"0	1	6	12"	45"
1 1/2"0	1	6	12"	42"
1 3/4"0				
2"0				
1/2"x1/2" and under	5	15	30"	35"
3/4" x 1/4" 	3	10	20"	35"
3/4"x5/8" and under	3	10	20"	35"
up to 1 1/4"x 1/2"	2	8	16"	35"
" 1 1/2"x1/2"	2	8	16"	35"
" 1 3/4"x1/2"	1	4	8"	54"
" 2 1/4"x1/"	1	5	10"	48"
" 4"x1/2"	1	6	12"	30"
Cult.Beam	1	5	10"	54"

The cutting was divided with respect to kind of stock into four main classes, namely, small rounds up to and including 3/4"; large rounds 7/8" and up, flats, and cultivator beam stock. This included most work and stock that did not come under any of these heads, such as angle iron, was figured, separately, however, in a similar manner.

Having determined the number of bars handled, at once the next thing was to decide how many strokes should be missed for handling each set of bars; our results on this point, also given in the table above, were of prime importance, and much time was spent in getting these correct. The number of strokes given in the table is the allowance when the bars are cut into pieces all of the same length. Often to use the stock economically, it is necessary to cut the last piece or even the last two pieces to different lengths. This is done with hand gages, and two extra strokes are allowed for each piece cut in this way. One stroke is missed between cutting the last piece of regular length and cutting the piece to the hand gage, and another stroke is lost putting this piece on a truck and putting the gage on the table of the machine, where it will be handy.

All cutting from bars was figured as done with a helper to pile the cuttings on a truck.

The delays allowed for shearing were determined as for punching, by observing the time that men lost for whole days at a time and deciding how much of this was necessary. These delays were found to be the same for all cutting and trimming, and are given below.

Shearing Delays.

Rest and toilet--------------------------60'00"

Oil (5) and clean (2) machines, and let roustabout clean (3) around machines----10'00"

Check setting of gage------------------ 5'00"

Count bars, measure, figure pieces, report, route and designate stock-----30'00"

Make out time slip---------------------- 8'00"

Outside delays, (job work, talking, receiving orders, helping others, delayed by trucking not his own)---------10'00"

123'00"

Percent of Detail time for necessary delays $\frac{123}{600-123}$ - -26%

Percent of Complete Time for necessary delays $\frac{123}{600}$ --20.5%

Outline of Method for figuring Shearing Prices.

I. Change knives. Separate price.

II. Actual work.

1. When machine is run continuously while cutting one bar.
    - a. No. pieces in bar, (calculated.)
    - b. No. of bars handled at time, (from table page 68.)
    - c. No. of strokes to handle this number of bars, (from table page 68.)
    - d. No. of bars on truck, (from table).
    - e. No. of pieces on small truck, (calculated).
    - f. Time lost on last pieces, (calculated).
    - g. Delays, (determined).

2. When machine is stopped after each cut.
   - a. Time of actual cutting per bar, or slab, and pieces per bar to get time per piece. Curve for various lengths.
   - b. Time of handling bar. (Same table as"c." above.)
   - c. No. of bars on trucks. (Same table as "d" above)
   - d. No. of pieces on small truck, (calculated).
   - e. Delays. (Same as "g" above).

In cutting very short pieces time was always lost cutting the last piece as the machine very often had to be stopped for these or they had to be cut one piece at a time, no matter how many had been cut at once before. The allowance for this loss is as follows:-

Pieces under 8" and over 6" long--------2"
" " 6" " " 4" " --------4"
" " 4" " " 2" " --------8"
" " 2" --------12"

The allowance is the same for all work, but its main use is on cutting bolts.

We are now ready to follow calculations for any of this work.

Cutting Small Rounds.

Prices for small rounds were figured by applying what is explained above except that it was necessary to make an allowance for crooked bars. As the stock came to the machines, it was bent so that it was necessary to cut one bar in every twenty by itself, as crooked bars cannot be shoved with others. This loss and the allowances made are given below, further amplified by cruve, plate 17.

To allow for crooked bars allow one bar per twenty to be put through one at a time and allow loss incident to this in cases where

more than one bar is handled at a time.

The loss is occasioned by the fact that it takes as long to cut one crooked bar as it would to cut six straight bars, when six can be handled at once. Crooked bars are of frequent occurrence and are caused by shipment and handling.

Now, I believe, I have given all of the details that enter into the calculations for cutting small rounds, and I will complete the explanation by giving an example from the actual figures.

3/8" stock. 5 bars handled at once.

5" to 6" long--5 1/2" is 36 pieces per bar.

Strokes up to last 2 pieces Time of strokes.

Time during bar---------35 x 1.65-----57.75"

Handle bars--30.00"

Lost on end of bars-------------------------------- 4.00"

91.75"

Addition for crooked bars-------------------------- 1.155

45875

45875

100925

105.97

Trucking-- 3.5

109.47

Total Detail Time $\frac{109.47}{180}$ -------------------.608"

Complete Time------.608" x 1.26 -------------.76608

Price per 1000 at 22 1/2¢ ------------------ 4 3/4¢

See plate 18 for prices for cutting small rounds.

Large Rounds.

For large rounds prices were figured to cover three conditions. First when all the pieces cut are the same length; second when the last piece is cut to a different length by a hand gage, and third,

when the last two pieces are cut to a different length by hand gage. In these last two cases these pieces of different length are to be turned in at the same price as the others. Then if there are four pieces of regular length and two of another length, the cutting is turned in as six pieces at the price for six pieces per bar, cutting the last two pieces to hand gage.

This is the only peculiarity of this class of work, and I will give one example of the calculation for each class of cutting.

1 1/4" stock. Last piece not cut to gage.

Six pieces per bar.

Time during bar -------6 x 1.94 --------11.64"

Handle bar--------6 x 1.94-------- 11.64"

Trucking------------------------- 4.6 "

27.88"

Total Detail Time $\frac{27.88}{6}$ -----4.65"

Complete Time----4.65" x 1.26=5.859

Price per 100 at 22 1/2¢ from curves - 3.7¢

1 1/4" Stock. Last piece cut to hand gage.

Six pieces per bar.

During bar, 5 strokes---5 x 1.94--- 9.70"

Cut last piece to gage--3 x 1.94--- 5.82"

Handle bars-------------6 x 1.94---11.64

Trucking-------------------------- 4.6 "

31.76"

Total Detail Time $\frac{31.76}{6}$-----5.293

Complete time---5.293 x 1.26=6.669"

Price per 100 at 22 1/2¢ -------------4.2¢

1 1/4"O Stock. Last two pieces cut to hand gage. Six pieces per bar.

During the bar, 4 strokes---4 x 1.94--- 7.76"
Cut last two bars to gage---6 x 1.94----11.64"
Handle bar-------------------------------11.64"
Trucking--------------------------------- 4.6 "
35.62"

Total Detail Time- $\frac{35.64}{6}$------5.94"
Complete Time---5.94 x 1.26 = 7.4844"
Price per 100 at 22 1/2¢ --------------4.7¢

See plate 19 for list of prices for cutting large rounds.

Flats.

Small flats, where as many as three bars are handled at a time, were figured the same except that they were on a basis of one bar handled at a time. In a great deal of the flat stock it was possible to have the helper cut the last piece while the machine man was getting the next bar. This is not possible with any other stock on account of the shape of the knives. Although this saving was small in some cases, separate prices were figured for these two methods throughout, and the cheaper is used whenever possible. The saving means just one stroke on each bar. The following list gives the divisions used to classify flat stock for applying prices as figured.

Divisions for Cutting Flat Stock.

5 bars at once, 3/8" square - 1/2" square.
3 bars at once, 7/8" x 1/2" and under.
2 bars at once. 3/4" square - 1 x 5/8" - 1 1/4" x 1/2"
1 1/2" x 3/8" - 1 3/4" x 5/16" - 2" x 1/4" and under.

Up to 2 1/4" x 1/2". 1" square - 1 1/4" x 7/8" - 1 1/2" x 3/4" - 1 3/4" x 5/8" - 2 1/4" x 1/2" - 2 1/2" x 7/16" - 3" x 3/8" 3 1/2" x 1/4" and under.

Up to 4" x 1/2". 1 1/4" square - 2" x 1" - 2 1/2" x 7/8" - 3" x 3/4" - 3 1/2" s 5/8" - 4" x 1/2" and under.

Above 4" x 1/2" - Special.

Examples of calculations for prices for cutting the same piece by the two methods are given below.

Up to 1 3/4" x 1/2". Helper cuts last piece.

Eight pieces per bar.

Time during bar --------7 x 1.92---13.44"
Handle bar---------------4 x 1.92--- 7.68"
Trucking--------------------------- 3.5 "
24.62"

Total Detail Time--$\frac{24.62''}{8}$----3.08"

Complete time---3.08 x 1.26-=3.88

Price per 100 at 22 1/2¢---------------2.4¢

Up to 1 3/4" x 1/2. Man cuts last piece.

Eight pieces per bar.

Time during bar-------- 8 x 1.92---15.36"
Handle bar -------------4 x 1.92--- 7.68"
Trucking--------------------------- 3.5 "
26.54"

Total Detail Time--$\frac{26.54}{8}$-----3.32"

Complete Time---3.32 x 1.26--4.1832

Price per 100 at 22 1/2¢---------------2.6¢

See plate 20 for price list for cutting flat stock.

Prices for cutting cultivator beam stock were figured exactly as for large rounds, and it is unnecessary to go into further details on them. See plate 20 for price list for cultivator stock.

Cutting with machine stopped between cuts made up another large class of work. For this the curves on plate 21 and 22 were plotted to give the time between cuts. The time for handling the bars was allowed the same as when the machine was run continuously. The time from starting a bar through to cutting the first piece was taken as 1" less than the time between pieces. The time to cut a piece to a hand gage was taken the same as between cuts. Below is given an example of the calculations for this work.

One bar handled at once. Over 1 1/8"0 or 2 1/4 x 1/2. Three pieces per bar.

Start through to cutting first piece---- 5 "
1st to 3rd pieces-------2 x 6-----------12 "
Handle bar---------------6 x 1.92---------11.52"
Trucking-------------------------------- 7.5 "
36.02"

Total Detail Time--$\frac{36.02}{3}$-----12 "
Complete time--12 x 1.26-----15.12"
Price per 100 at 22 1/2¢ --------------9.4¢
Prices for this work are listed in plates 18, 19 and 20.

There is a large amount of trimming work and cutting to pattern for which prices were figured by the same general methods as the other prices. The trimming of plow beams and the calculations for the prices afford a good example of the method of getting at prices on the work, and I give the curves used to determine these prices with explanations. See plate 23.

In the investigation of this work, it was divided into the following elementary times, trim front end or "A", mark rear end "B"; trim "B"; put beam on truck. While shear man was doing this his helper marked the front end and got the next beam to the machine. The trucking was taken as usual from the trucking curves. The detail time for each of these operations is laid off, in the upper left hand corner, on axes of time and weight. After points to correspond to all observations were laid off, curves were drawn in to give the averages. These gave us correct detail times for the individual elementary operations. The curves in the lower portion of the chart represent the various combinations of these elementary operations, that make up the work on different classes of beams. Each of these curves gives us the total detail time for that class of beams. The curves in the upper right hand corner are derived from these and give the price for each class of beams in terms of the weight.

In order to simplify matters, we divided all beams into five regular classes as explained on the curve, and these included all beams up to 110 pounds. Those above 110 pounds were considered separately, as there are very few of these made. For each class an average price was taken as the price for the class. For list of prices for trimming beams as determined by curves, see plate 24. It is no exaggeration to say that the output per machine at present is between two and three times what is was when the work was done day work. The tonnage that passes through a shear varies greatly, but reaches a maximum equal to fifty tons per day. The men make better wages, and thus we are able to hold a better class of men on the work with the result that even at the increased speed the work is done more accurately than formerly.

The End.

S95-5C.-8-05.

DEERE & CO.

MESSENGER: This copy to Specification Clerk.

DECISION MEMO.

No. .... NUMBER TO BE ENTERED ONLY BY SPEC. CLERK. **Date** ....

PLEASE MAKE SPECIFICATIONS CONFORM TO THE FOLLOWING MEMO.

NOTE.—BE EXACT. GIVE NUMBERS OF OLD AND NEW PIECES. SURE!

PROPOSED BY	APPROVED: SALES DEPT.
RECORDED AND COPIES ISSUED	PURCHASING
	OPERATING

S96-2M-8-05.

DEERE & CO.

DECISION COPY.

No... **Date**..

MESSENGER: DELIVER ONE COPY TO EACH, AS BELOW:

Experimental Room:	Master Mechanic:	Piece Rate Division:	Order Division:
Sign and return to Spec. Clerk when all patterns required by this decision are completed.	Sign and return to Spec. Clerk when all new or altered tools required are ready for use.	Sign and return to Spec. Clerk when all new piece rates or changed prices are determined.	Sign and return to Spec. Clerk when all stock to manufacture under this decision is in hand.
....	....	....	....

A Decision System.

There are three forms used for operating the Decision System herewith described. Forms 1, 2, and 3 on pages 78 and 79. Form one is used as the original copy and amounts to a request for change as may be specified, but becomes a decision when approved by the proper authorities. After approval four copies are made out on form two and are sent to the parties designated at the foot of the page, and pursue a course as suggested by the printed matter. Form three is ordinary onion paper on which copies are typewriten, and sent to all the various foremen of the plant. The decision copies not only authorize resulting changes, but orders such changes. Copies to foremen are posted in a Mark Twain Scrap Book, all such copies are numbered consecutively for the purpose of enabling the foreman to check and keep his record of copies complete.

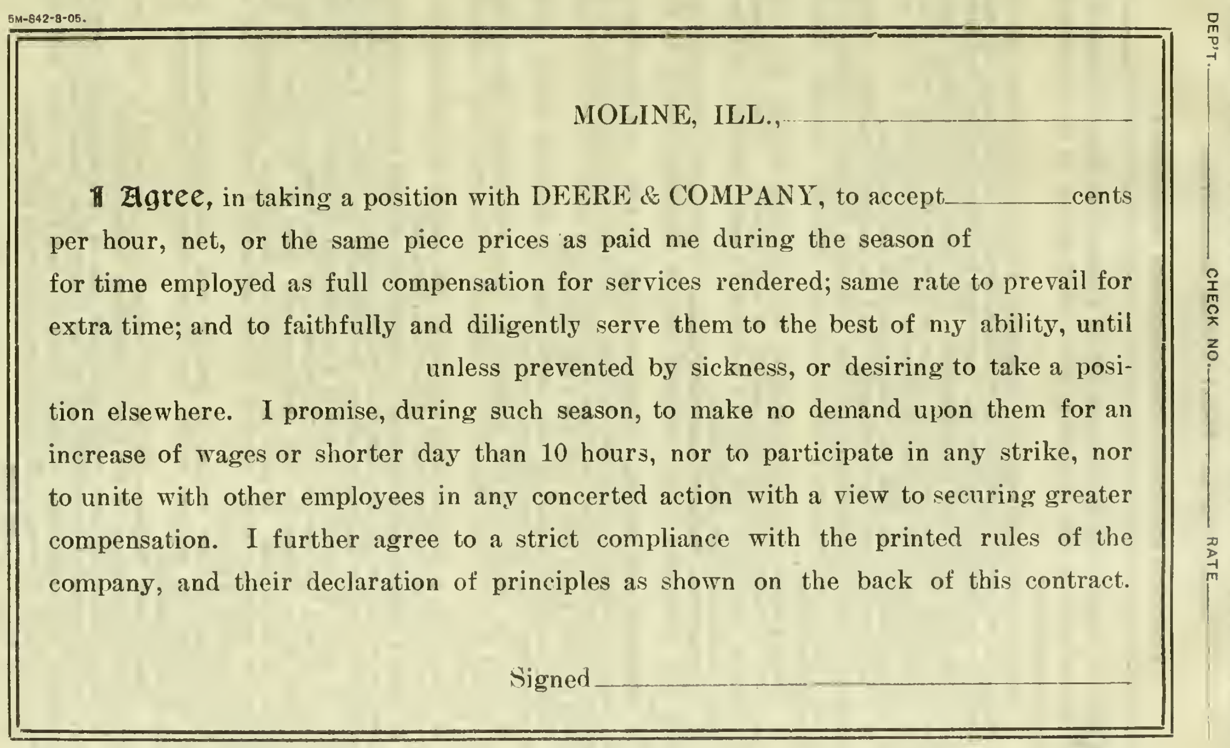
Decisions cover the floowing changes:-

1. Changes in goods.
2. Changes in methods of manufacturing.
3. Disposition of stock on hand and extras.

Requiring decisions for changing methods does not in any way limit the foreman's authority, but is for the purpose of informing all parties concerned and that following or resulting changes may be taken care of.

Anyone from foreman up has the authority to write the original decision, or a request for a decision covering all changes in mind. Thus suggestions for improvements are in no way limited.

Plate 1.



DEP'T.______________ CHECK NO.______________ RATE______________

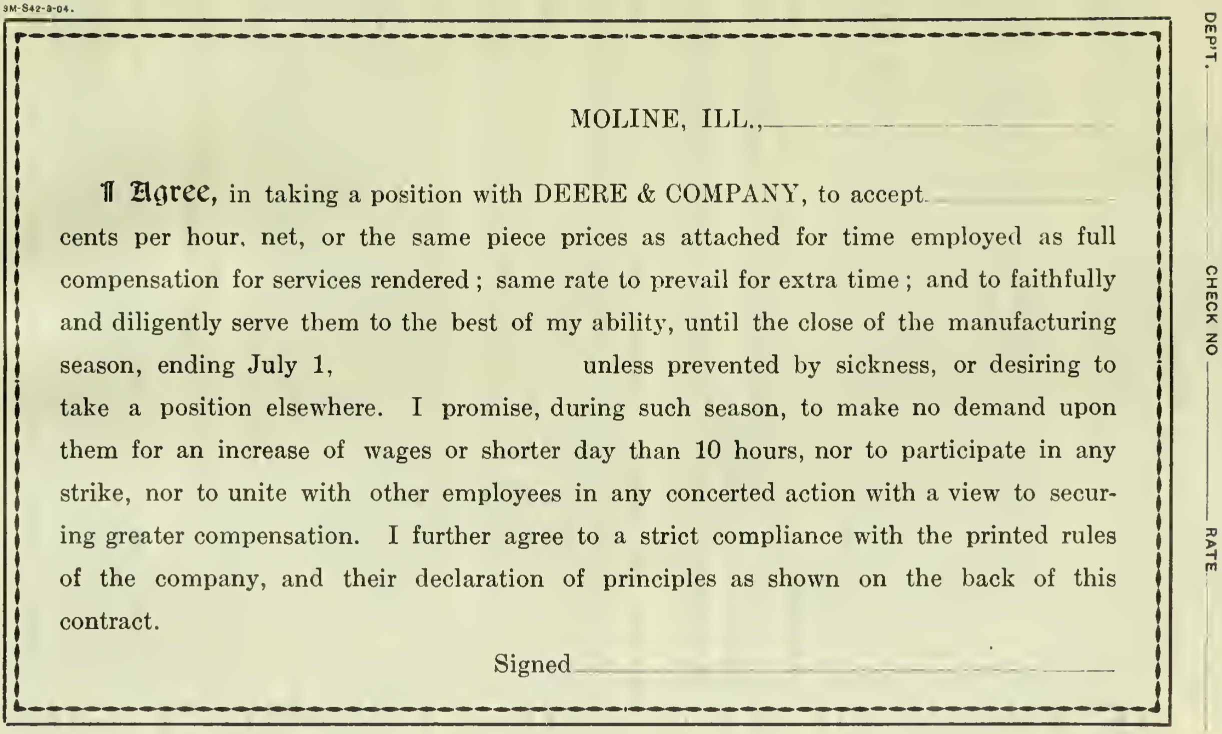
MOLINE, ILL.,______________

I Agree, in taking a position with DEERE & COMPANY, to accept________cents per hour, net, or the same piece prices as paid me during the season of for time employed as full compensation for services rendered; same rate to prevail for extra time; and to faithfully and diligently serve them to the best of my ability, until unless prevented by sickness, or desiring to take a position elsewhere. I promise, during such season, to make no demand upon them for an increase of wages or shorter day than 10 hours, nor to participate in any strike, nor to unite with other employees in any concerted action with a view to securing greater compensation. I further agree to a strict compliance with the printed rules of the company, and their declaration of principles as shown on the back of this contract.

Signed______________

5M-842-8-05.

Plate 2.



DEP'T.________ CHECK NO ________ RATE________

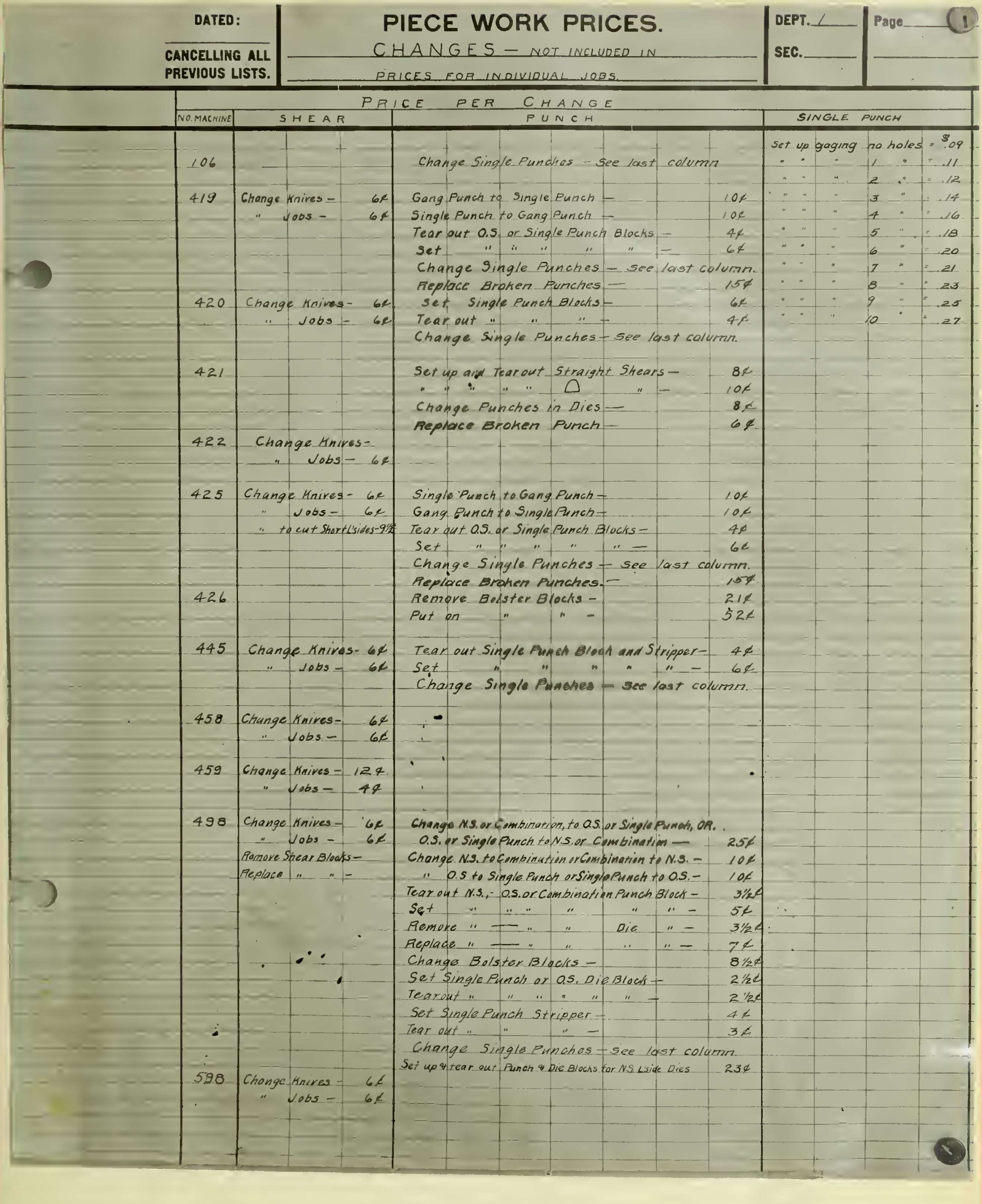
3M-842-3-04.

MOLINE, ILL.,____________

I Agree, in taking a position with DEERE & COMPANY, to accept________ cents per hour, net, or the same piece prices as attached for time employed as full compensation for services rendered ; same rate to prevail for extra time ; and to faithfully and diligently serve them to the best of my ability, until the close of the manufacturing season, ending July 1, unless prevented by sickness, or desiring to take a position elsewhere. I promise, during such season, to make no demand upon them for an increase of wages or shorter day than 10 hours, nor to participate in any strike, nor to unite with other employees in any concerted action with a view to securing greater compensation. I further agree to a strict compliance with the printed rules of the company, and their declaration of principles as shown on the back of this contract.

Signed________________

Plate 4.



DATED:

CANCELLING ALL PREVIOUS LISTS.

PIECE WORK PRICES.

CHANGES — NOT INCLUDED IN PRICES FOR INDIVIDUAL JOBS.

DEPT. 1

SEC.

Page

PRICE PER CHANGE

NO. MACHINE	SHEAR		PUNCH	
106			Change Single Punches – See last column	
419	Change Knives –	6¢	Gang Punch to Single Punch –	10¢
	" Jobs –	6¢	Single Punch to Gang Punch –	10¢
			Tear out O.S. or Single Punch Blocks –	4¢
			Set " " " " " –	6¢
			Change Single Punches – See last column.	
			Replace Broken Punches –	15¢
420	Change Knives –	6¢	Set Single Punch Blocks –	6¢
	" Jobs –	6¢	Tear out " " " –	4¢
			Change Single Punches – See last column.	
421			Set up and Tear out Straight Shears –	8¢
			" " " " " ∩ " –	10¢
			Change Punches in Dies –	8¢
			Replace Broken Punch –	6¢
422	Change Knives –			
	" Jobs –	6¢		
425	Change Knives –	6¢	Single Punch to Gang Punch –	10¢
	" Jobs –	6¢	Gang Punch to Single Punch –	10¢
	" to cut Short L'sides –	9½¢	Tear out O.S. or Single Punch Blocks –	4¢
			Set " " " " " –	6¢
			Change Single Punches – See last column.	
			Replace Broken Punches. –	15¢
426			Remove Bolster Blocks –	21¢
			Put on " " –	52¢
445	Change Knives –	6¢	Tear out Single Punch Block and Stripper –	4¢
	" Jobs –	6¢	Set " " " " " –	6¢
			Change Single Punches – See last column.	
458	Change Knives –	6¢		
	" Jobs –	6¢		
459	Change Knives –	12¢		
	" Jobs –	4¢		
498	Change Knives –	6¢	Change N.S. or Combination, to O.S. or Single Punch, OR.	
	" Jobs –	6¢	O.S. or Single Punch to N.S. or Combination —	25¢
	Remove Shear Blocks –		Change N.S. to Combination or Combination to N.S. –	10¢
	Replace " " –		" O.S to Single Punch or Single Punch to O.S. –	10¢
			Tear out N.S., O.S. or Combination Punch Block –	3½¢
			Set " " " " " " –	5¢
			Remove " — " " Die " –	3½¢
			Replace " — " " " " –	7¢
			Change Bolster Blocks –	8½¢
			Set Single Punch or O.S. Die Block –	2½¢
			Tearout " " " " " " –	2½¢
			Set Single Punch Stripper –	4¢
			Tear out " " " –	3¢
			Change Single Punches – See last column.	
			Set up & tear out Punch & Die Blocks for N.S. L'side Dies	23¢
598	Change Knives –	6¢		
	" Jobs –	6¢		

SINGLE PUNCH

Set up	gaging	no holes	= $.09
" "	"	1 "	= .11
" "	"	2 "	= .12
" "	"	3 "	= .14
" "	"	4 "	= .16
" "	"	5 "	= .18
" "	"	6 "	= .20
" "	"	7 "	= .21
" "	"	8 "	= .23
" "	"	9 "	= .25
" "	"	10 "	= .27

OPERATION

DATE
MEN
REMARKS

DEPT.
MATERIALS

TOOLS AND MACHINES

SHEET NO.

PLATE 5

	DESCRIPTION AND TIME OF DETAIL OPERATIONS	Time		Time		Time		Time		Time		Time		Time		Time		Time		Time		Av.Ti	
		M.	S.	M.	S.	M.	S.	M.	S.	M.	S.	M.	S.	M.	S.	M.	S.	M.	S.	M.	S.	M.	
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45																							

Total Detail Time

TIME	Date	COMPLETE OPERATION

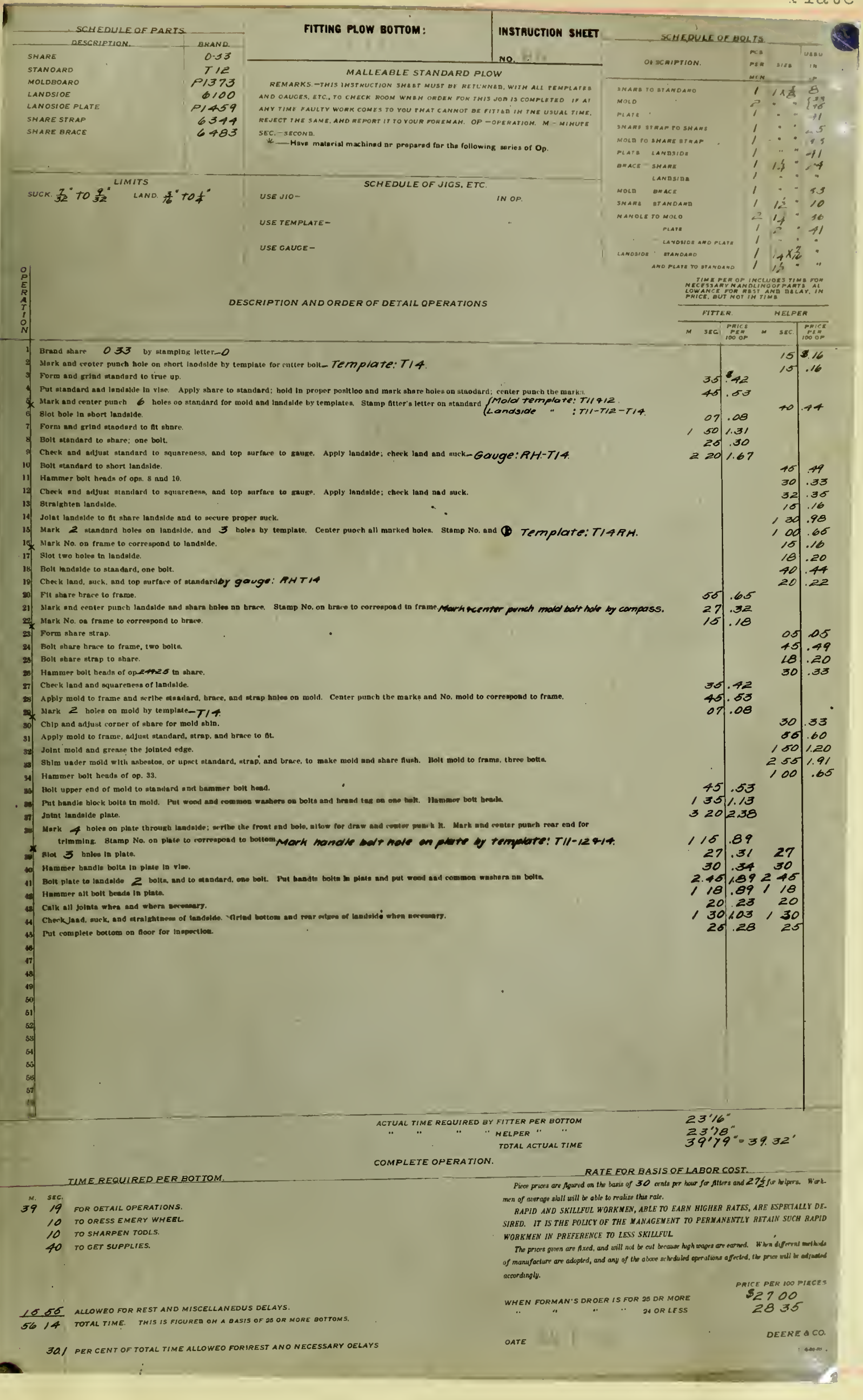
Total Time per Complete Operation—Includes Time for Rest and Necessary Delays

Per Cent of Time Consumed in Rest and Necessary Delays

1000-1-06-S 106

OBSERVE

Plate 6.



SCHEDULE OF PARTS	
DESCRIPTION.	BRAND.
SHARE	0-33
STANDARD	T12
MOLDBOARD	P1373
LANDSIDE	6100
LANDSIDE PLATE	P1459
SHARE STRAP	6344
SHARE BRACE	6483

FITTING PLOW BOTTOM:

INSTRUCTION SHEET

NO.

MALLEABLE STANDARD PLOW

REMARKS.—THIS INSTRUCTION SHEET MUST BE RETURNED, WITH ALL TEMPLATES AND GAUGES, ETC., TO CHECK ROOM WHEN ORDER FOR THIS JOB IS COMPLETED. IF AT ANY TIME FAULTY WORK COMES TO YOU THAT CANNOT BE FITTED IN THE USUAL TIME, REJECT THE SAME, AND REPORT IT TO YOUR FOREMAN. OP —OPERATION. M — MINUTE SEC. —SECOND.

* —Have material machined or prepared for the following series of Op.

SCHEDULE OF BOLTS			
DESCRIPTION.	PCS PER MCH	SIZE	USED IN OP
SHARE TO STANDARD	1	1 x 5/8	8
MOLD	2	" "	33 35
PLATE	1	" "	41
SHARE STRAP TO SHARE	1	" "	25
MOLD TO SHARE STRAP	1	" "	33
PLATE LANDSIDE	1	" "	41
BRACE SHARE	1	1½ "	24
LANDSIDE	1	" "	"
MOLD BRACE	1	" "	33
SHARE STANDARD	1	1½ "	10
HANDLE TO MOLD	2	1¼ "	36
PLATE	1	2 "	41
LANDSIDE AND PLATE	1	" "	"
LANDSIDE STANDARD	1	1¼ x 7/16 "	"
AND PLATE TO STANDARD	1	1½ "	"

LIMITS

SUCK. 7/32" TO 9/32" LAND. 3/16" TO 1/4"

SCHEDULE OF JIGS, ETC.

USE JIG— IN OP.

USE TEMPLATE— "

USE GAUGE—

TIME PER OP INCLUDES TIME FOR NECESSARY HANDLING OF PARTS. ALLOWANCE FOR REST AND DELAY, IN PRICE, BUT NOT IN TIME.

OPERATION	DESCRIPTION AND ORDER OF DETAIL OPERATIONS	FITTER. M	FITTER. SEC.	FITTER. PRICE PER 100 OP	HELPER M	HELPER SEC.	HELPER PRICE PER 100 OP
1	Brand share 0 33 by stamping letter—0					15	$.16
2	Mark and center punch hole on short landside by template for cutter bolt—Template: T14.					15	.16
3	Form and grind standard to true up.		35	$.42			
4	Put standard and landside in vise. Apply share to standard; hold in proper position and mark share holes on standard; center punch the marks.		45	.53			
5*	Mark and center punch 6 holes on standard for mold and landside by templates. Stamp fitter's letter on standard {Mold template: T11 & 12. Landside " : T11-T12-T14.					40	.44
6	Slot hole in short landside.		07	.08			
7	Form and grind standard to fit share.	1	50	1.31			
8	Bolt standard to share; one bolt.		25	.30			
9	Check and adjust standard to squareness, and top surface to gauge. Apply landside; check land and suck—Gauge: RH-T14.	2	20	1.67			
10	Bolt standard to short landside.					45	.49
11	Hammer bolt heads of ops. 8 and 10.					30	.33
12	Check and adjust standard to squareness, and top surface to gauge. Apply landside; check land and suck.					32	.35
13	Straighten landside.					15	.16
14	Joint landside to fit share landside and to secure proper suck.				1	30	.98
15	Mark 2 standard holes on landside, and 3 holes by template. Center punch all marked holes. Stamp No. and ◐ Template: T14RH.				1	00	.65
16*	Mark No. on frame to correspond to landside.					15	.16
17	Slot two holes in landside.					18	.20
18	Bolt landside to standard, one bolt.					40	.44
19	Check land, suck, and top surface of standard by gauge: RHT14					20	.22
20	Fit share brace to frame.		55	.65			
21	Mark and center punch landside and share holes on brace. Stamp No. on brace to correspond to frame. Mark & center punch mold bolt hole by compass.		27	.32			
22*	Mark No. on frame to correspond to brace.		15	.18			
23	Form share strap.					05	.05
24	Bolt share brace to frame, two bolts.					45	.49
25	Bolt share strap to share.					18	.20
26	Hammer bolt heads of op. 24 & 25 to share.					30	.33
27	Check land and squareness of landside.		35	.42			
28	Apply mold to frame and scribe standard, brace, and strap holes on mold. Center punch the marks and No. mold to correspond to frame.		45	.53			
29*	Mark 2 holes on mold by template—T14.		07	.08			
30	Chip and adjust corner of share for mold shin.					30	.33
31	Apply mold to frame, adjust standard, strap, and brace to fit.					55	.60
32	Joint mold and grease the jointed edge.				1	50	1.20
33	Shim under mold with asbestos, or upset standard, strap, and brace, to make mold and share flush. Bolt mold to frame, three bolts.				2	55	1.91
34	Hammer bolt heads of op. 33.				1	00	.65
35	Bolt upper end of mold to standard and hammer bolt head.		45	.53			
36	Put handle block bolts in mold. Put wood and common washers on bolts and brand tag on one bolt. Hammer bolt heads.	1	35	1.13			
37	Joint landside plate.	3	20	2.38			
38*	Mark 4 holes on plate through landside; scribe the front end hole, allow for draw and center punch it. Mark and center punch rear end for trimming. Stamp No. on plate to correspond to bottom. Mark handle bolt hole on plate by template: T11-12 & 14.	1	15	.89			
39	Slot 3 holes in plate.		27	.31		27	
40	Hammer handle bolts in plate in vise.		30	.34		30	
41	Bolt plate to landside 2 bolts, and to standard, one bolt. Put handle bolts in plate and put wood and common washers on bolts.	2.	45	1.89	2	45	
42	Hammer all bolt heads in plate.	1	18	.89	1	18	
43	Calk all joints when and where necessary.		20	.23		20	
44	Check land, suck, and straightness of landside. Grind bottom and rear edges of landside when necessary.	1	30	1.03	1	30	
45	Put complete bottom on floor for inspection.		25	.28		25	
46							
47							
48							
49							
50							
51							
52							
53							
54							
55							
56							
57							

ACTUAL TIME REQUIRED BY FITTER PER BOTTOM 23'16"
" " " " HELPER " " 23'78"
TOTAL ACTUAL TIME 39'79" = 39.32'

COMPLETE OPERATION.

TIME REQUIRED PER BOTTOM.

M.	SEC.	
39	19	FOR DETAIL OPERATIONS.
	10	TO DRESS EMERY WHEEL.
	10	TO SHARPEN TOOLS.
	40	TO GET SUPPLIES.
16	56	ALLOWED FOR REST AND MISCELLANEOUS DELAYS.
56	14	TOTAL TIME. THIS IS FIGURED ON A BASIS OF 25 OR MORE BOTTOMS.

30.1 PER CENT OF TOTAL TIME ALLOWED FOR REST AND NECESSARY DELAYS

RATE FOR BASIS OF LABOR COST.

Piece prices are figured on the basis of 30 cents per hour for fitters and 27½ for helpers. Workmen of average skill will be able to realize this rate.

RAPID AND SKILLFUL WORKMEN, ABLE TO EARN HIGHER RATES, ARE ESPECIALLY DESIRED. IT IS THE POLICY OF THE MANAGEMENT TO PERMANENTLY RETAIN SUCH RAPID WORKMEN IN PREFERENCE TO LESS SKILLFUL.

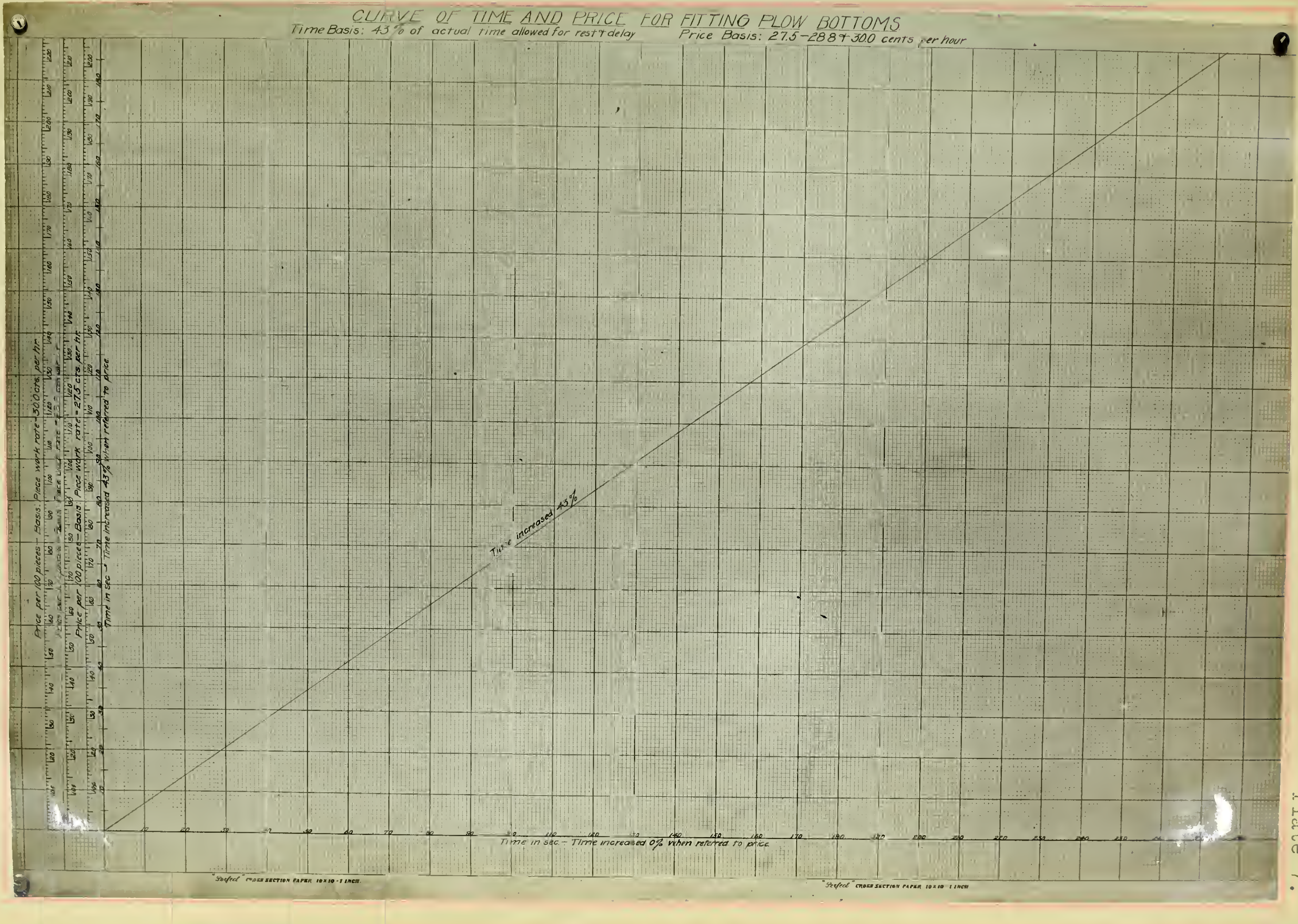
The prices given are fixed, and will not be cut because high wages are earned. When different methods of manufacture are adopted, and any of the above scheduled operations affected, the price will be adjusted accordingly.

	PRICE PER 100 PIECES
WHEN FOREMAN'S ORDER IS FOR 25 OR MORE	$27 00
" " " " 24 OR LESS	28 35

DATE

DEERE & CO.

Plate 7.



CURVE OF TIME AND PRICE FOR FITTING PLOW BOTTOMS

Time Basis: 43% of actual time allowed for rest + delay Price Basis: 27.5–28.8 + 30.0 cents per hour

Plate 8.

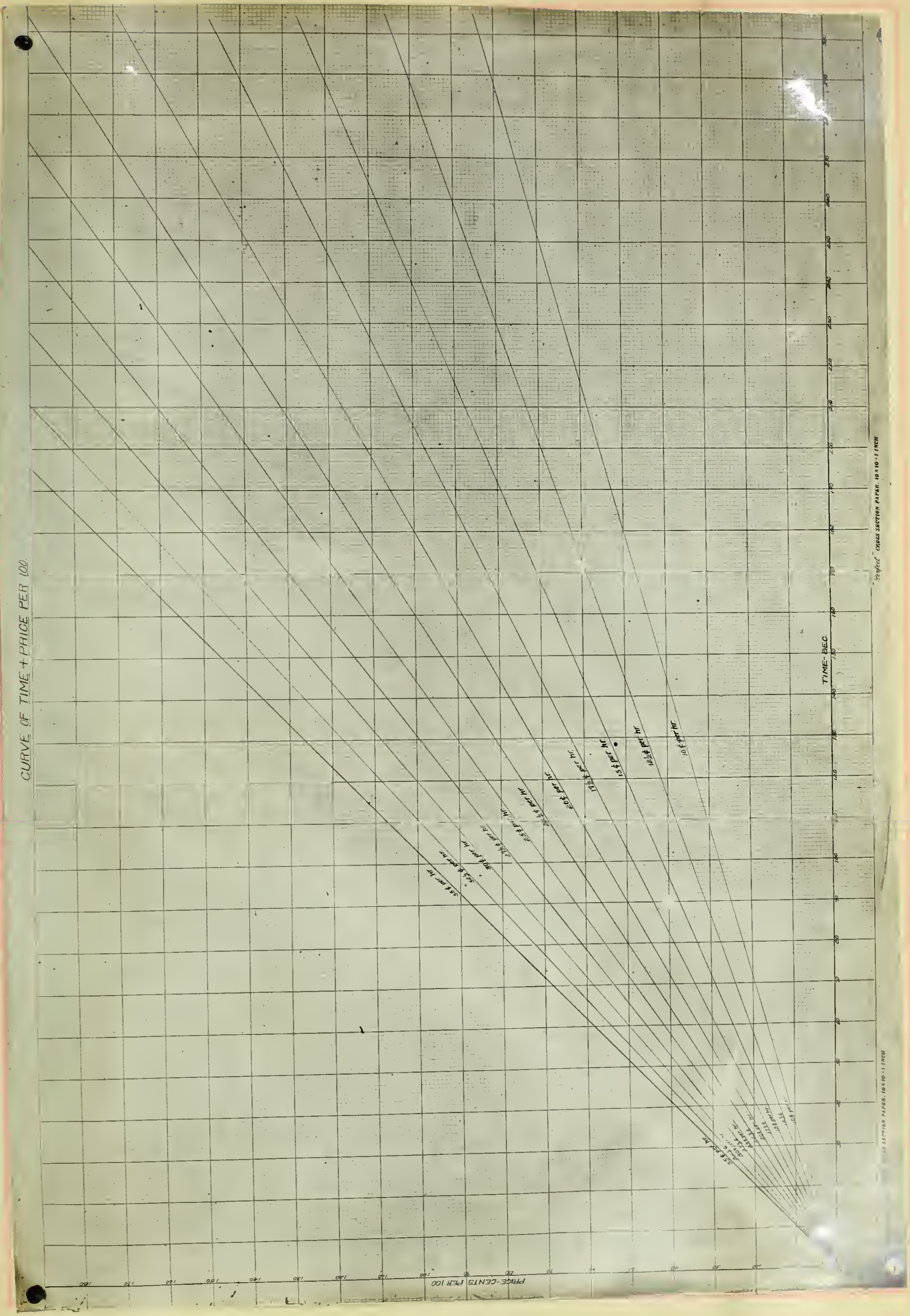
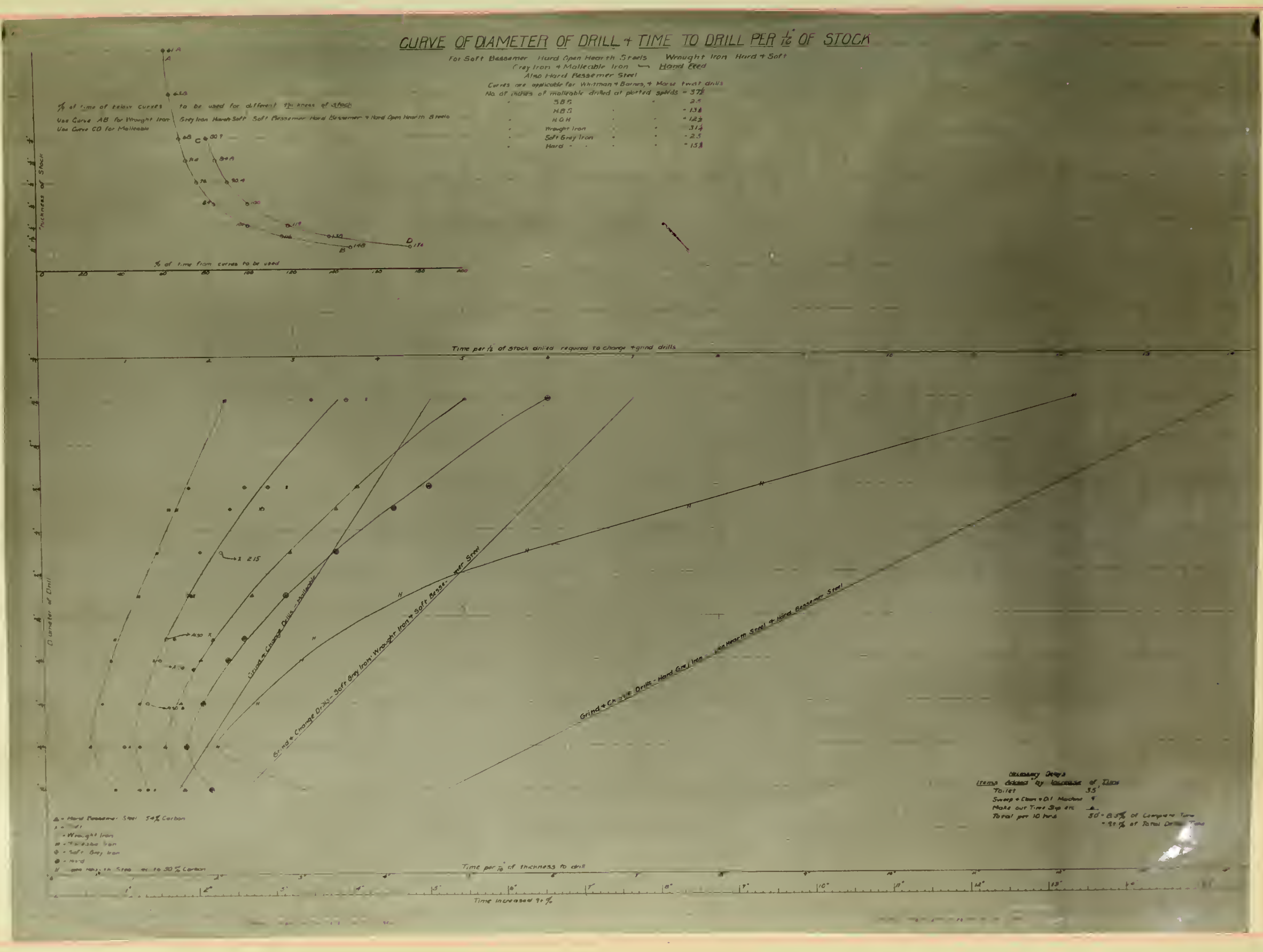

CURVE OF TIME + PRICE PER 100
TIME-SEC.
PRICE-CENTS PER 100
35¢ per hr.
32½¢ per hr.
30¢ per hr.
27½¢ per hr.
25¢ per hr.
22½¢ per hr.
20¢ per hr.
17½¢ per hr.
15¢ per hr.
12½¢ per hr.
10¢ per hr.
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
"Perfect" CROSS SECTION PAPER. 10 x 10 - 1 INCH

Plate 9.



CURVE OF DIAMETER OF DRILL + TIME TO DRILL PER 1/16" OF STOCK

For Soft Bessemer Hard Open Hearth Steels Wrought Iron Hard + Soft
Grey Iron + Malleable Iron — Hand Feed
Also Hard Bessemer Steel
Curves are applicable for Whitman + Barnes, + Morse twist drills
No. of inches of malleable drilled at plotted speeds = 37½
" SBS " " = 25
" HBS " " = 13½
" HOH " " = 12½
" Wrought Iron " " = 31¼
" Soft Grey Iron " " = 25
" Hard " " = 15½

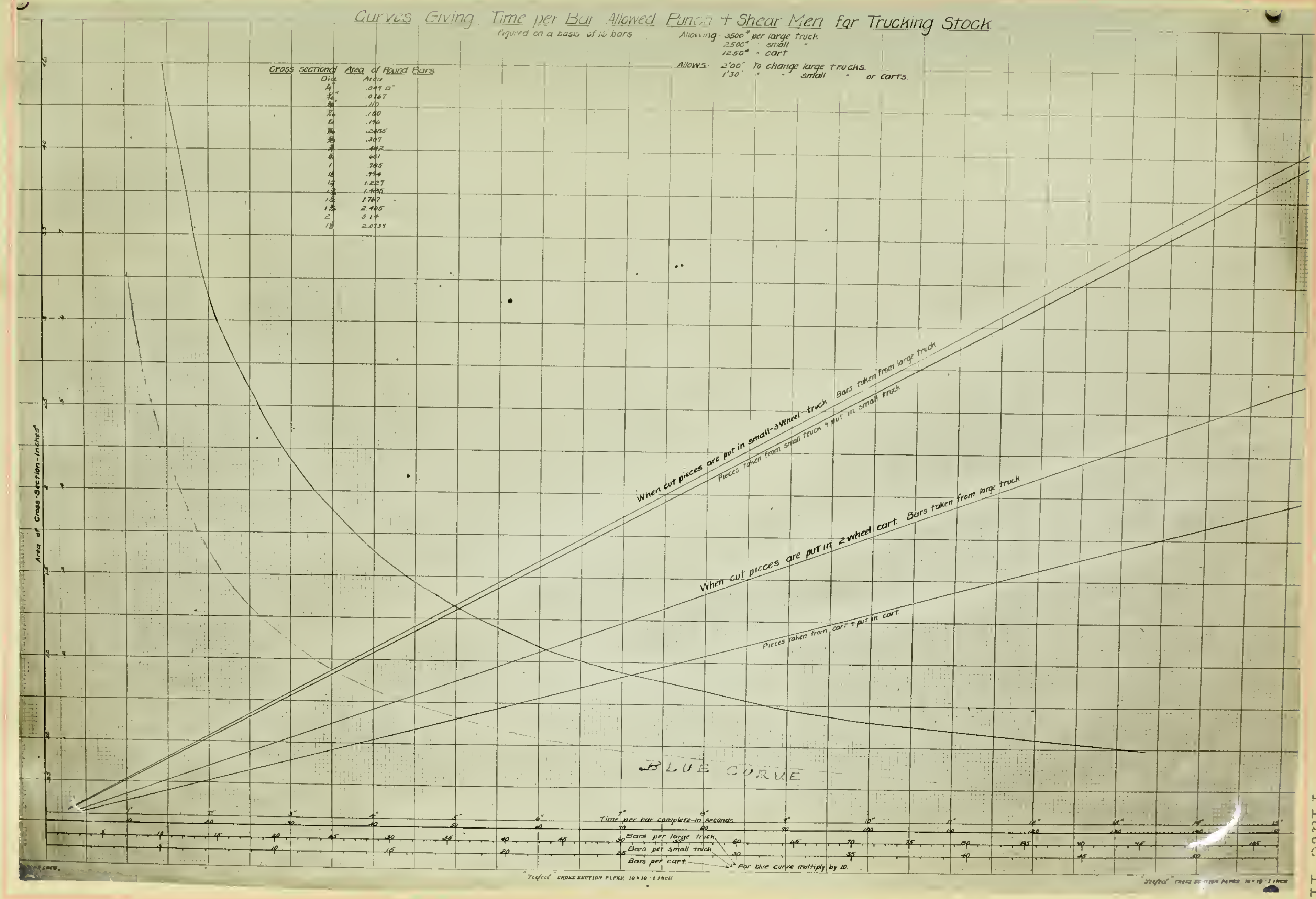
% of time of below curves to be used for different thickness of stock
Use Curve AB for Wrought Iron Grey Iron Hard + Soft Soft Bessemer Hard Bessemer + Hard Open Hearth Steels
Use Curve CD for Malleable

Necessary Delays
Items Added by Increase of Time
Toilet 35'
Sweep + Clean + Oil Machine 9'
Make out Time Slip etc. 6'
Total per 10 hrs. 50' = 8.5% of Complete Time
= 9.1% of Total Drill Time

Speed of punch and shear presses.

Machine No.	Time per stroke.	R. P. M.
110	1.62"	37.50
419	1.88"	32.26
420	1.62"	37.04
421	1.88"	32.26
422	1.94"	30.93
425	1.94"	30.93
426	2.24"	26.78
445	2.00"	30.00
458	1.62"	37.04
490	4.28"	14.22
498	1.92"	31.60
106	2.04"	30.00
459	2.20"	27.2

Plate 11.



Curves Giving Time per Bar Allowed Punch + Shear Men for Trucking Stock

Figured on a basis of 10 bars

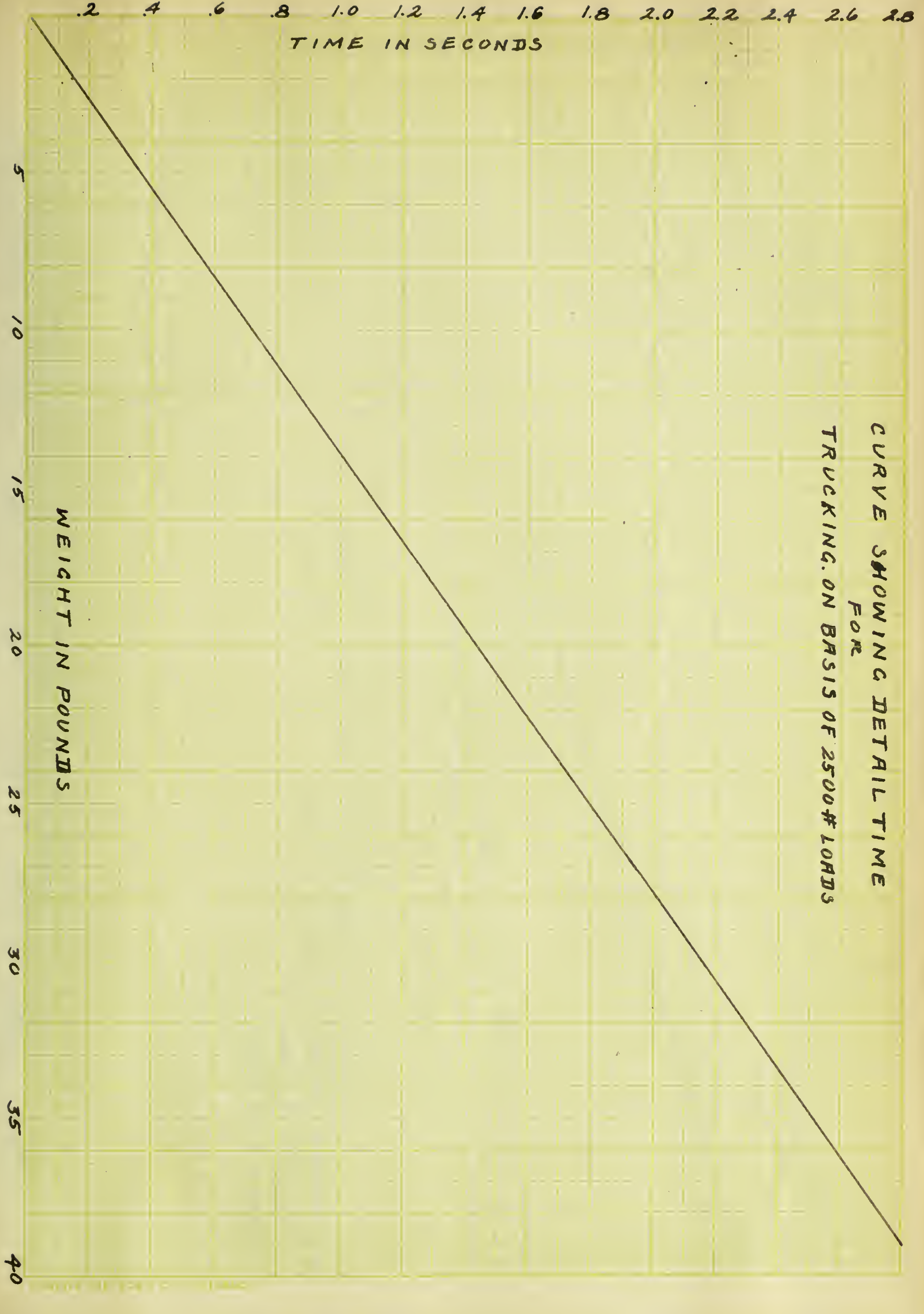
Allowing - 3500# per large truck
2500# - small "
1250# - cart

Allows - 2'00" to change large trucks
1'30" " " small " or carts.

Cross sectional Area of Round Bars

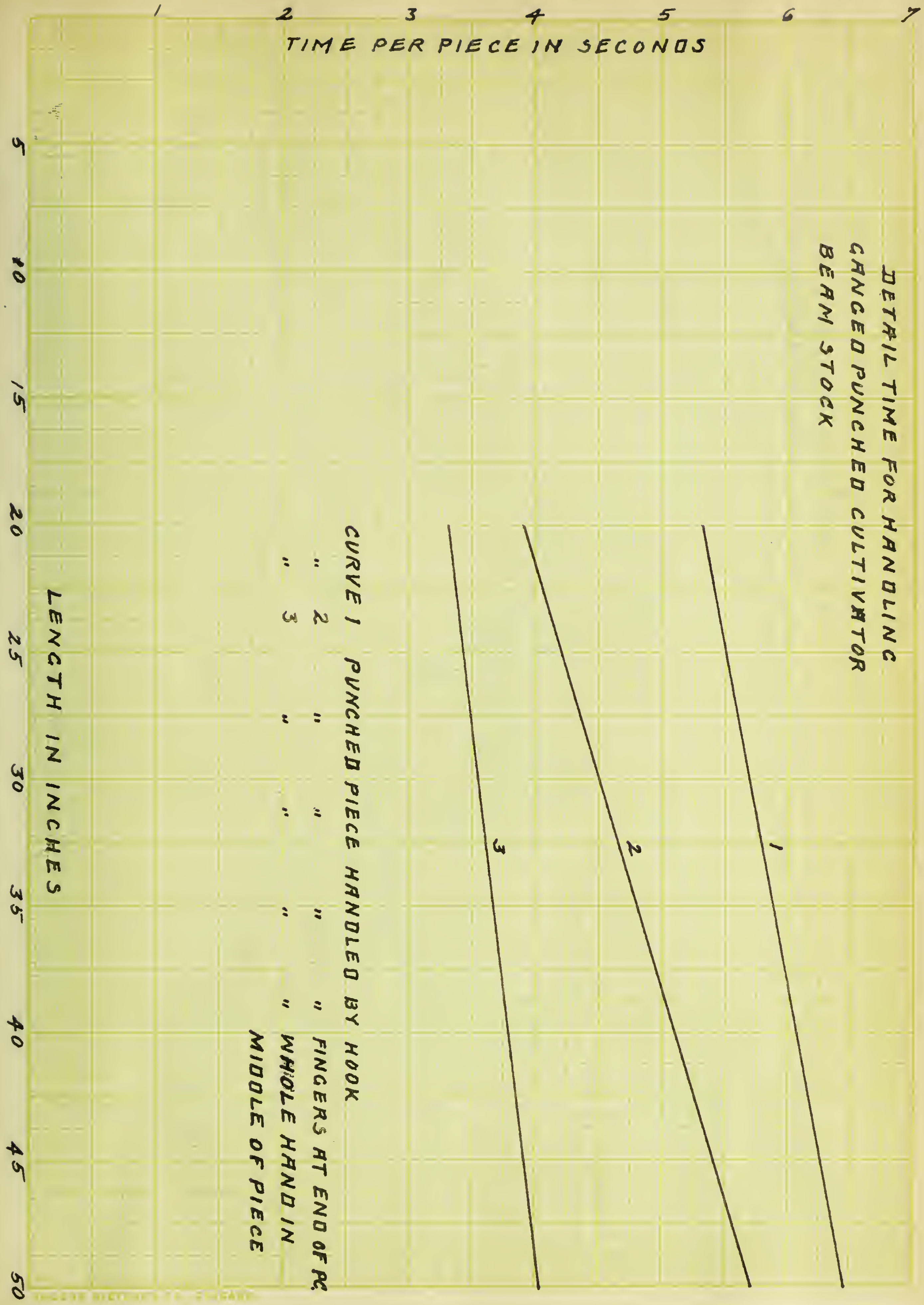
Dia.	Area
1/4"	.049 □"
5/16"	.0767
3/8"	.110
7/16	.150
1/2	.196
9/16	.2485
5/8	.307
3/4	.442
7/8	.601
1	.785
1 1/8	.994
1 1/4	1.227
1 3/8	1.485
1 1/2	1.767
1 3/4	2.405
2	3.14
1 5/8	2.0734

PLATE 12



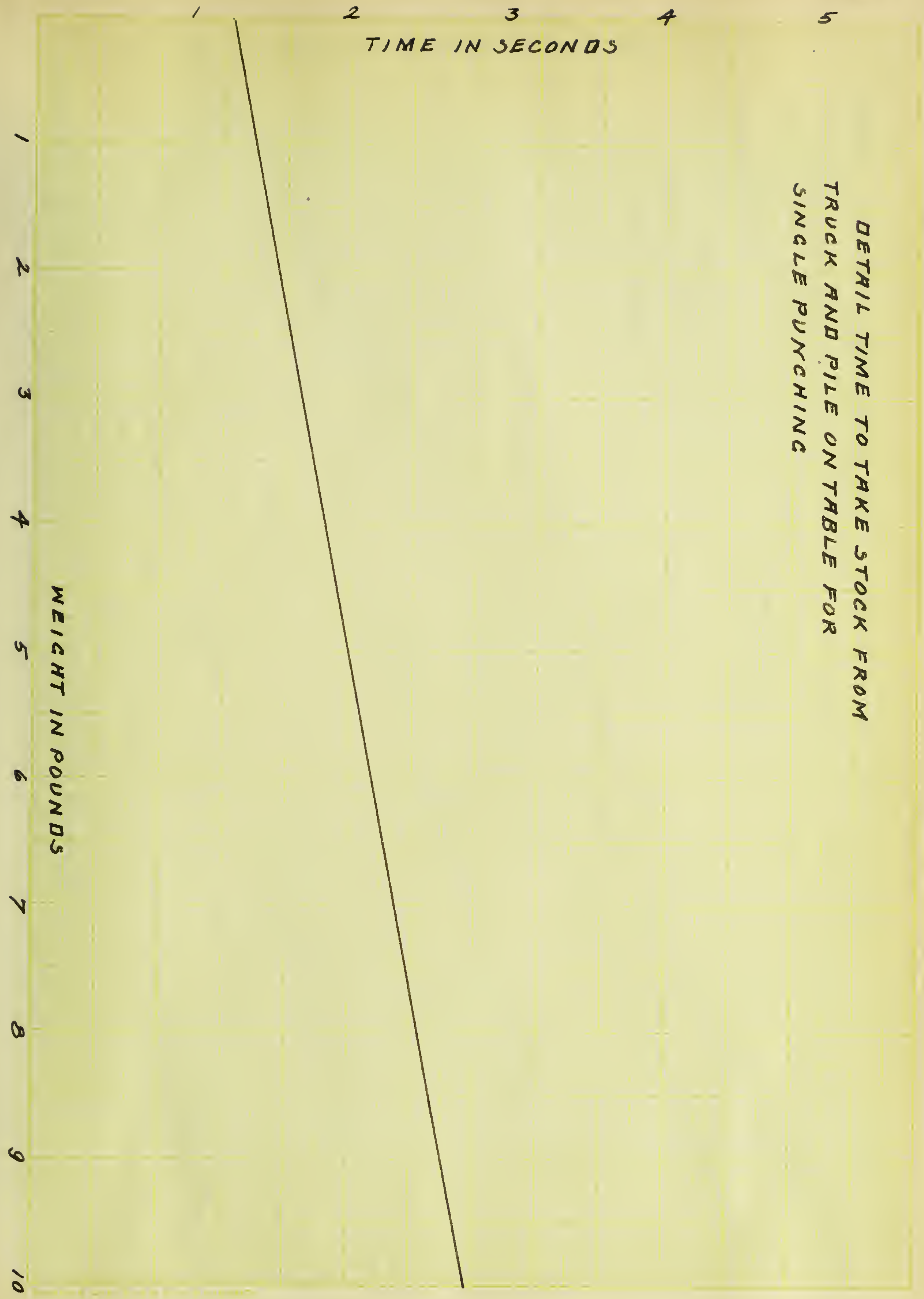
CURVE SHOWING DETAIL TIME FOR TRUCKING. ON BASIS OF 2500# LOADS

PLATE 13



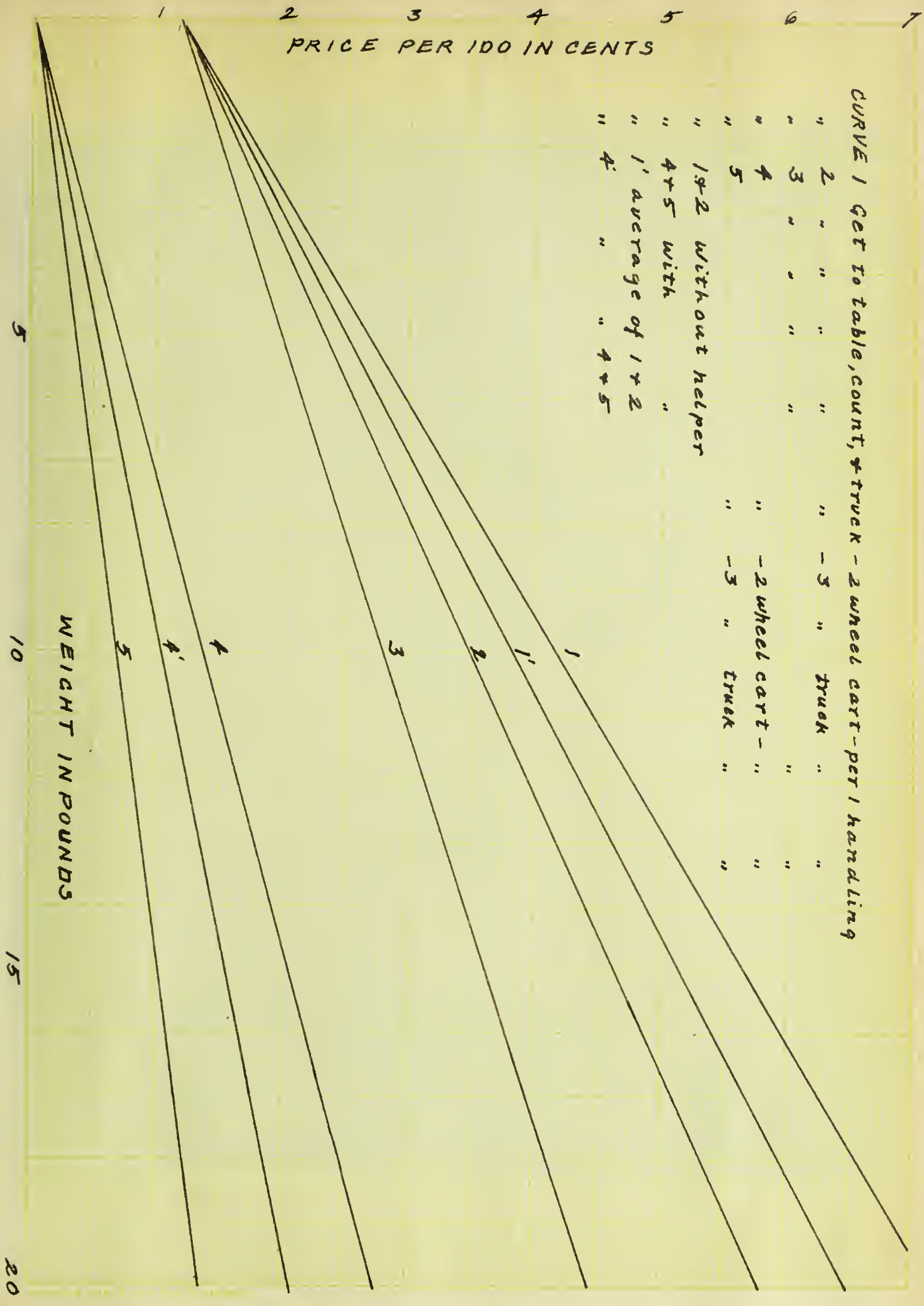
DETAIL TIME FOR HANDLING GANGED PUNCHED CULTIVATOR BEAM STOCK

PLATE 14



DETAIL TIME TO TAKE STOCK FROM TRUCK AND PILE ON TABLE FOR SINGLE PUNCHING

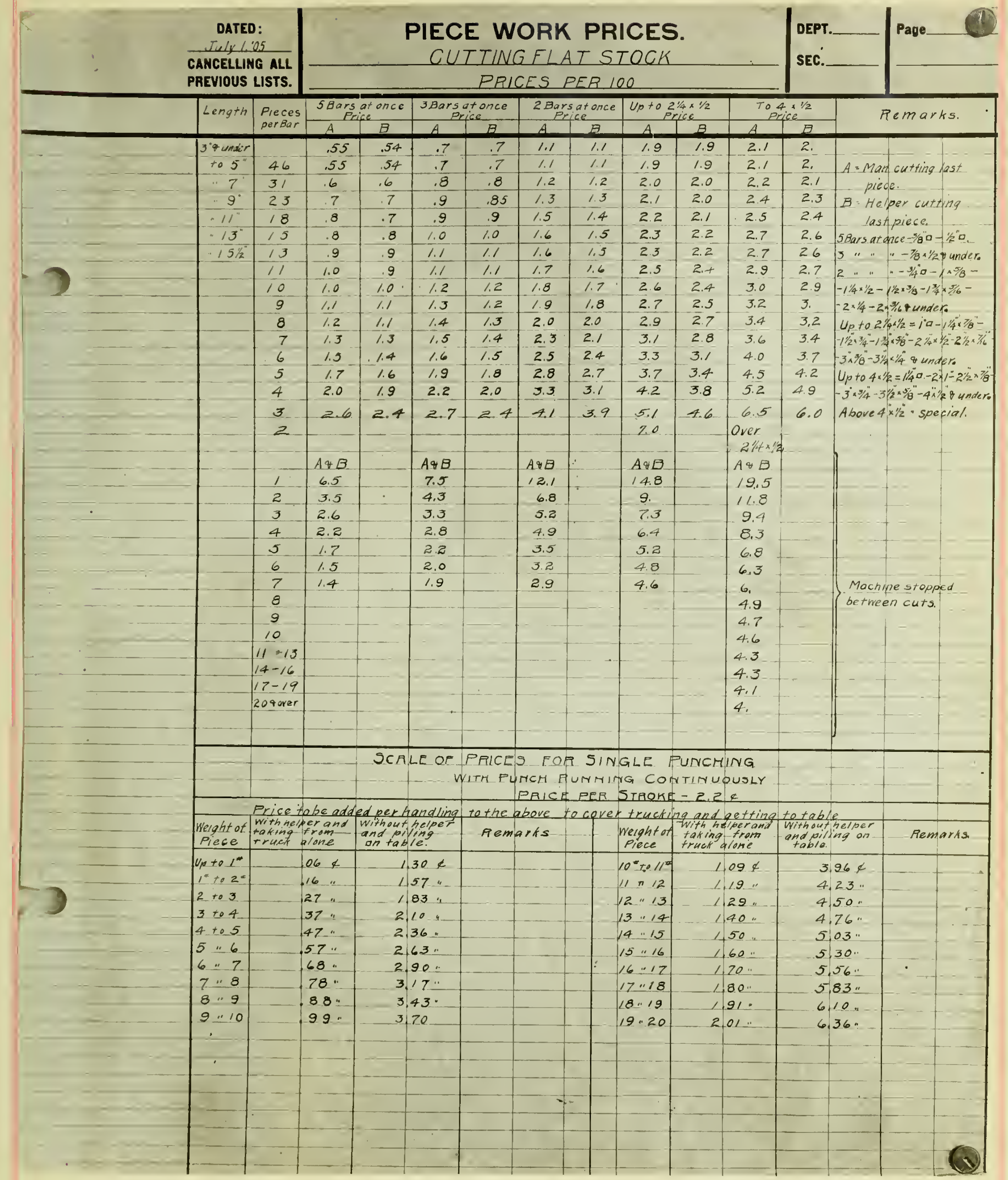
PLATE 15


PRICE PER 100 IN CENTS
1
2
3
4
5
6
7
CURVE 1 Get to table, count, & truck - 2 wheel cart - per 1 handling
" 2 " " " " - 3 " truck " "
" 3 " " " " " " "
" 4 " " " - 2 wheel cart - " "
" 5 " " " - 3 " truck " "
" 1 & 2 without helper
" 4 & 5 with "
" 1' average of 1 & 2
" 4' " " 4 & 5
1
1'
2
3
4
4'
5
WEIGHT IN POUNDS
5
10
15
20

MEDICAL (Graduate)

[illegible]

Plate 16.



DATED: July 1, '05
CANCELLING ALL PREVIOUS LISTS.

PIECE WORK PRICES.

CUTTING FLAT STOCK

PRICES PER 100

DEPT.
SEC.
Page

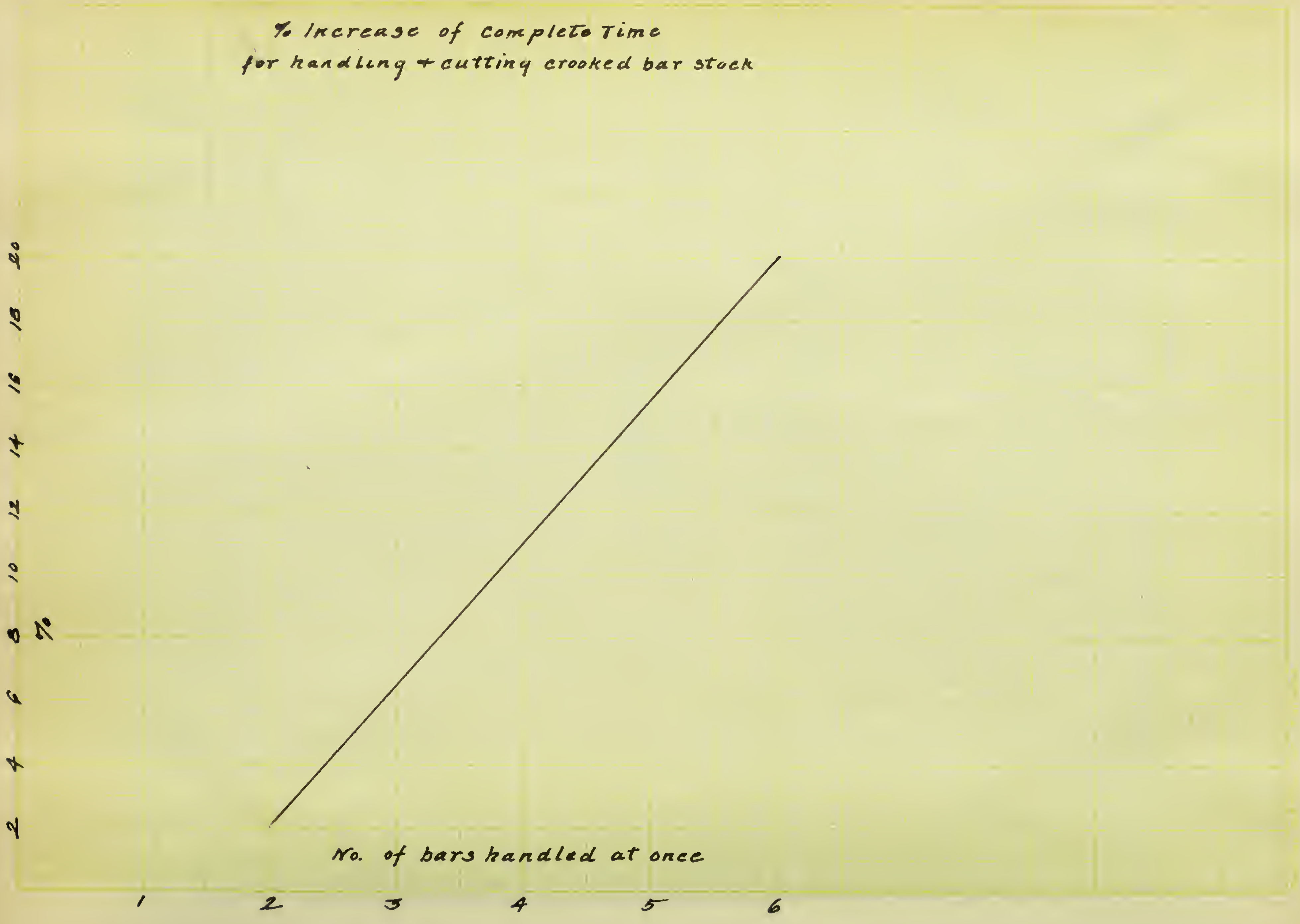
Length	Pieces per Bar	5 Bars at once Price A	5 Bars at once Price B	3 Bars at once Price A	3 Bars at once Price B	2 Bars at once Price A	2 Bars at once Price B	Up to 2¼ x ½ Price A	Up to 2¼ x ½ Price B	To 4 x ½ Price A	To 4 x ½ Price B	Remarks.
3" & under		.55	.54	.7	.7	1.1	1.1	1.9	1.9	2.1	2.	
to 5"	46	.55	.54	.7	.7	1.1	1.1	1.9	1.9	2.1	2.	A = Man cutting last
" 7"	31	.6	.6	.8	.8	1.2	1.2	2.0	2.0	2.2	2.1	piece.
" 9"	23	.7	.7	.9	.85	1.3	1.3	2.1	2.0	2.4	2.3	B = Helper cutting
" 11"	18	.8	.7	.9	.9	1.5	1.4	2.2	2.1	2.5	2.4	last piece.
" 13"	15	.8	.8	1.0	1.0	1.6	1.5	2.3	2.2	2.7	2.6	5 Bars at once – 3/8"□ – 1/2"□.
" 15½"	13	.9	.9	1.1	1.1	1.6	1.5	2.3	2.2	2.7	2.6	3 " " " – 7/8 x 1/2 & under.
	11	1.0	.9	1.1	1.1	1.7	1.6	2.5	2.4	2.9	2.7	2 " " " – 3/4"□ – 1 x 5/8 –
	10	1.0	1.0	1.2	1.2	1.8	1.7	2.6	2.4	3.0	2.9	– 1¼ x ½ – 1½ x 3/8 – 1¾ x 5/16 –
	9	1.1	1.1	1.3	1.2	1.9	1.8	2.7	2.5	3.2	3.	– 2 x ¼ – 2 x 3/16 & under.
	8	1.2	1.1	1.4	1.3	2.0	2.0	2.9	2.7	3.4	3.2	Up to 2¼ x ½ = 1"□ – 1¼" x 7/8" –
	7	1.3	1.3	1.5	1.4	2.3	2.1	3.1	2.8	3.6	3.4	– 1½" x ¾" – 1¾" x 5/8" – 2¼" x ½" – 2½ x 7/16"
	6	1.5	1.4	1.6	1.5	2.5	2.4	3.3	3.1	4.0	3.7	– 3" x 3/8" – 3½" x ¼" & under.
	5	1.7	1.6	1.9	1.8	2.8	2.7	3.7	3.4	4.5	4.2	Up to 4 x ½ = 1¼"□. – 2" x 1" – 2½" x 7/8"
	4	2.0	1.9	2.2	2.0	3.3	3.1	4.2	3.8	5.2	4.9	– 3" x ¾" – 3½" x 5/8" – 4" x ½" & under.
	3	2.6	2.4	2.7	2.4	4.1	3.9	5.1	4.6	6.5	6.0	Above 4" x ½" – special.
	2							7.0		Over		
										2¼ x ½		
		A & B		A & B		A & B		A & B		A & B		
	1	6.5		7.5		12.1		14.8		19.5		
	2	3.5		4.3		6.8		9.		11.8		
	3	2.6		3.3		5.2		7.3		9.4		
	4	2.2		2.8		4.9		6.4		8.3		
	5	1.7		2.2		3.5		5.2		6.8		
	6	1.5		2.0		3.2		4.8		6.3		
	7	1.4		1.9		2.9		4.6		6.		Machine stopped between cuts.
	8									4.9		
	9									4.7		
	10									4.6		
	11 – 13									4.3		
	14 – 16									4.3		
	17 – 19									4.1		
	20 & over									4.		

SCALE OF PRICES FOR SINGLE PUNCHING
WITH PUNCH RUNNING CONTINUOUSLY
PRICE PER STROKE – 2.2 ¢

Price to be added per handling to the above to cover trucking and getting to table

Weight of Piece	With helper and taking from truck alone	Without helper and piling on table.	Remarks	Weight of Piece	With helper and taking from truck alone	Without helper and piling on table.	Remarks.
Up to 1#	.06 ¢	1.30 ¢		10# to 11#	1.09 ¢	3.96 ¢	
1# to 2#	.16 "	1.57 "		11 " 12	1.19 "	4.23 "	
2 to 3	.27 "	1.83 "		12 " 13	1.29 "	4.50 "	
3 to 4	.37 "	2.10 "		13 " 14	1.40 "	4.76 "	
4 to 5	.47 "	2.36 "		14 " 15	1.50 "	5.03 "	
5 " 6	.57 "	2.63 "		15 " 16	1.60 "	5.30 "	
6 " 7	.68 "	2.90 "		16 " 17	1.70 "	5.56 "	
7 " 8	.78 "	3.17 "		17 " 18	1.80 "	5.83 "	
8 " 9	.88 "	3.43 "		18 " 19	1.91 "	6.10 "	
9 " 10	.99 "	3.70		19 " 20	2.01 "	6.36 "	

PLATE 17



% Increase of complete Time
for handling + cutting crooked bar stock

DATED:
July 1. 1905
CANCELLING ALL
PREVIOUS LISTS.

PIECE WORK PRICES.

CUTTING BOLTS.

PRICES PER 1000

DEPT. B
SEC. 1
Page

Length	Pieces per Bar.	1/4" & 5/16" O 6 Bars	3/8" O 5 Bars.	7/16 & 1/2" O 4 Bars.	9/16 & 5/8" O 3 Bars.	3/4" O 2 Bars.	Remarks.
2 & under		3¼¢	3¾¢	4½¢	5½¢	7¾¢	
Up to 3"		3½ "	4 "	4¾ "	5¾ "	8 "	Price for changing knives — 6¢
3 · 4		4 "	4¼ "	5 "	6¼ "	8½ "	" " " jobs — 6¢
4 · 5		4 "	4½ "	5¼ "	6½ "	8¾ "	
5 " 6		4¼ "	4¾ "	5½ "	6¾ "	9 "	
6 " 7		4½ "	5 "	6 "	7 "	9¼ "	
7 " 8		5 "	5½ "	6¼ "	7½ "	9¾ "	
8 " 9		5 "	5¾ "	6½ "	7½ "	10 "	
9 " 10		5¼ "	6 "	6¾ "	7¾ "	10¼ "	
10 " 12	17	5¾ "	6½ "	7¼ "	8½ "	10¾ "	
12 " 13½	15	6¼ "	6¾ "	7¾ "	9¾ "	12½ "	
13½ "	13	6¾ "	7½ "	8½ "	10¼ "	13 "	
	12	7¼ "	7¾ "	8¾ "	11 "	13½ "	
	11	7½ "	8¼ "	9¼ "	11¼ "	14 "	
	10	8 "	8¾ "	9¾ "	11¾ "	14½ "	
	9	8¾ "	9¼ "	10½ "	12½ "	15½ "	
	8	9½ "	10¼ "	11½ "	13¼ "	16½ "	
	7	10½ "	11¼ "	12½ "	14½ "	17½ "	
	6	11¾ "	12½ "	14 "	16 "	19 "	
	5	13½ "	14½ "	16 "	18 "	21½ "	
	4	16 "	18	19 "	21 "	25 "	
			PRICES PER 100				
	4	1.8	2.0	2.4	2.8	3.7	Machine stopped between cuts.
	3	2.2	2.4	2.8	3.3	4.3	
	2	3.0	3.2	3.8	4.4	5.5	
	1	5.5	5.9	6.8	7.7	9.4	

CUTTING CULTIVATOR BEAM STOCK

Length	Pieces per Bar	Price per 100. A	Price per 100. B	Price per 100. C	Remarks.
6" to 10"	Av 24	2.1¢	1.9¢	2.2¢	A = Last piece cut to gage.
10 " 14	" 16	2.4 "	2.2 "	2.5 "	B = " " not " " "
14 " 18	" 12	2.6 "	2.3 "	2.8 "	C -2 " " " " "
	" 10	2.8 "	2.5 "	3.1 "	
	9	2.9 "	2.6 "	3.2 "	
	8	3.1 "	2.7 "	3.5 "	Price for changing knives - 6¢
	7	3.3 "	2.9 "	3.7 "	" " " jobs - 6¢
	6	3.6 "	3.1 "	4.1 "	
	5	4.0 "	3.4 "	4.6 "	
	4	4.6 "	3.9 "	5.4 "	
		A & B			
	4	6.1¢			Machine stopped between cuts.
	3	6.8 "			
	2	8.3 "			
	1	13.5 "			

Plate 19.

DATED: July 1-1905
CANCELLING ALL
PREVIOUS LISTS.

PIECE WORK PRICES.

Cut Round Stock 7/8" Diam. and Over

DEPT. B
SEC. 1

7/8 Round

Length of Piece	Pieces per Bar	Price A	Price B	Price C
3" & under	45	1.8	1.7	1.9
Up to 5"	33	1.9	18	2.0
7"	22	2.0	1.9	2.2
9	16	2.2	2.0	2.4
11"	13	2.4	22	2.6
13"	11	2.6	2.3	2.8
	9	2.7	24	3.0
	8	2.9	2.5	3.2
	7	3.0	2.6	3.5
	6	3.3	2.8	3.8
	5	3.7	3.0	4.3
	4	4.2	3.4	5.0
	3	5.1	4.1	6.1
		A&B		
	4	5.8		
	3	6.4		
	2	7.7		
	1	12.2		

1" Round

Length of Piece	Pieces per Bar	Price A	Price B	Price C
3" & under	54	1.8	1.7	1.8
5	40	1.9	1.8	1.9
7	27.	2.0	1.9	2.0
9	20	2.2	2.0	2.2
11	16	2.3	2.1	2.4
13	13	2.5	2.3	2.6
15	11	2.7	2.4	2.8
	10	2.8	2.5	3.0
	9	2.8	2.5	3.1
	8	3.0	2.6	3.3
	7	3.1	2.7	3.6
	6	3.4	2.9	3.9
	5	3.8	3.2	4.4
	4	4.4	3.6	5.1
		A&B		
	4	5.8		
	3	6.4		
	2	7.7		
	1	12.2		

1 1/8" Round

Length of Piece	Pieces per Bar	Price A	Price B	Price C
3" & under.	54	1.8	1.8	1.8
Up to 5	40	1.9	1.8	1.9
7	27	2.1	2.0	2.1
9	20	2.3	2.1	2.4
11	16	2.5	2.3	2.6
13	13	2.7	2.5	2.8
15	11	2.8	2.5	3.0
16.3	10	2.9	2.6	3.2
18.6	9	3.0	2 7	3.4
21.2	8	3 2	2.8	3.6
24.8	7	3.5	3.0	3.9
29.7	6	3.8	3.3	4.3
37.5	5	4.2	3.6	4.9
40.	4	5.0	4.2	5.7
		A&B		
	4	6.4		
	3	7.2		
	2	8.8		
	1	14.4		

Remarks.

A = Last pc. cut to gage
B: " "not" " "
C = 2 " " " " "

Length of Bars Taken
7/8" ○ – 11'4"
1" ○ – 13'5"
1 1/8" ○ – 13'5"
1 1/4" ○ – 15'6"
1 3/8" ○ – 13'2
1 1/2" ○ – 12'0"

Length of piece given in column to apply to pieces cut to gage only.

Machine stopped between cuts.

1 1/4" Round

Length of Piece	Pieces per Bar	Price A	Price B	Price C
3" & under	62	1.8	1.8	1.9
Up to 5"	46	1.9	1.9	2.0
5 - 7	31	2.1	2.0	2.2
7 - 9	23	2.3	2.2	2.4
9 - 11	18	2.5	2.3	2.7
11 - 13	15	2.7	2.5	2.9
13 to 15.8	13	2.9	2.6	3.1
to 17.4	11	3.0	2.7	3.2
to 19.3	10	3.1	2.8	3.4
to 21.75	9	3.3	2.9	3.6
to 24.8	8	3.5	3.1	3.9
to 29	7	3.8	3.4	4.2
to 34.8	6	4.2	3.7	4 7
to 40.	5	4.7	4.1	5.3
	4		4.7	
		A&B		
	4	7.8		
	3	8.8		
	2	10.8		
	1	18.0		

1 3/8" Round

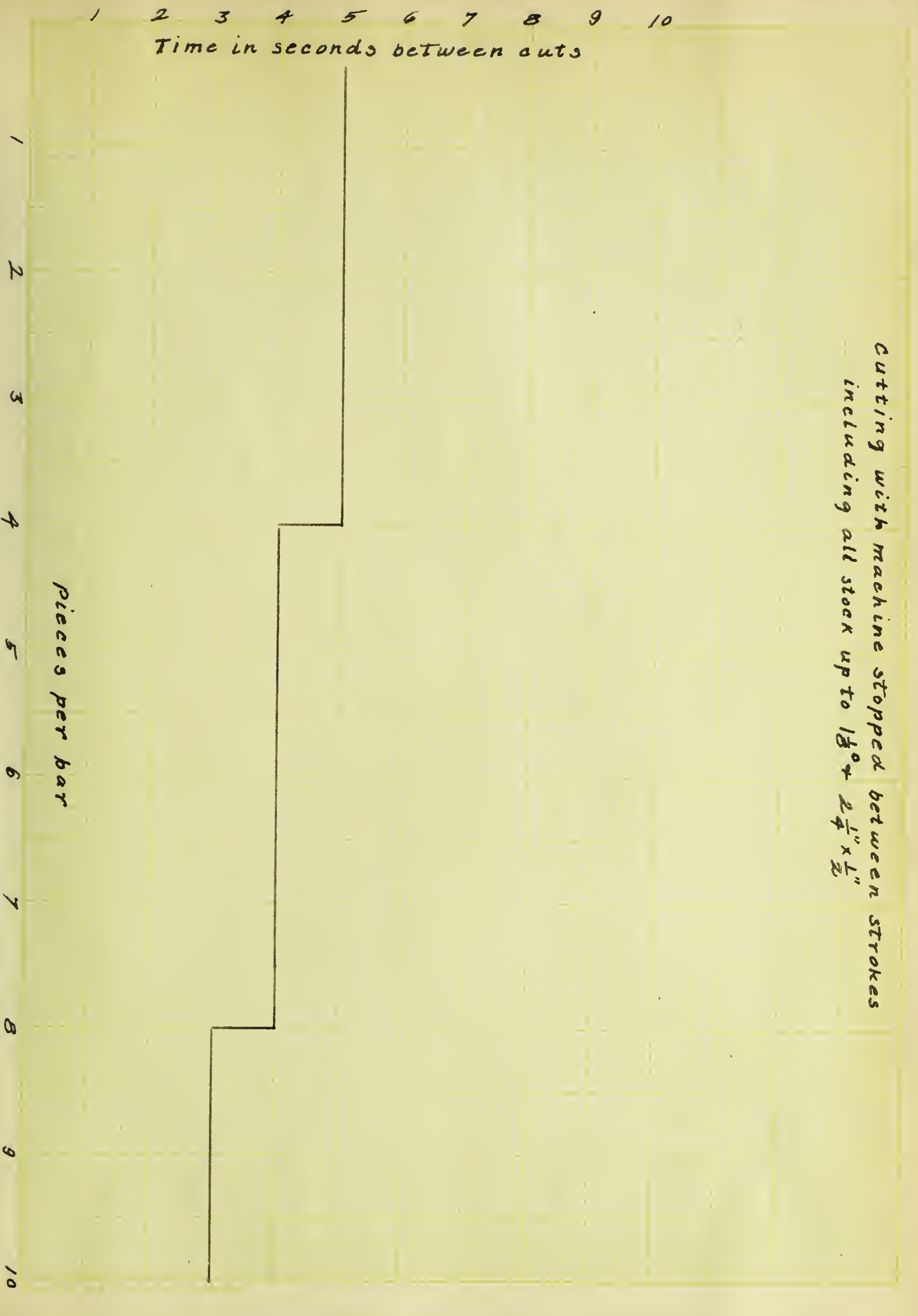
Length of Piece	Pieces per Bar	Price A	Price B	Price C
3" & under	52	1.9	1.8	1.9
to 5	39	2.0	1.9	2 1
7	26	2.2	2.1	2.3
9	19	2.5	2.3	2.6
11	15	2.7	2.6	2.9
13	13	2.9	2.7	3.1
15	11	3.1	2.9	3.4
	9	3.3	3.0	3.6
	8	3.5	3.1	3.9
	7	3 8	3.4	4.2
	6	4.2	3.7	4.7
	5	4.7	4.1	5.3
	4	5.5	4.8	6.3
		A&B		
	4	7.8		
	3	8.8		
	2	10.8		
	1	18.0		

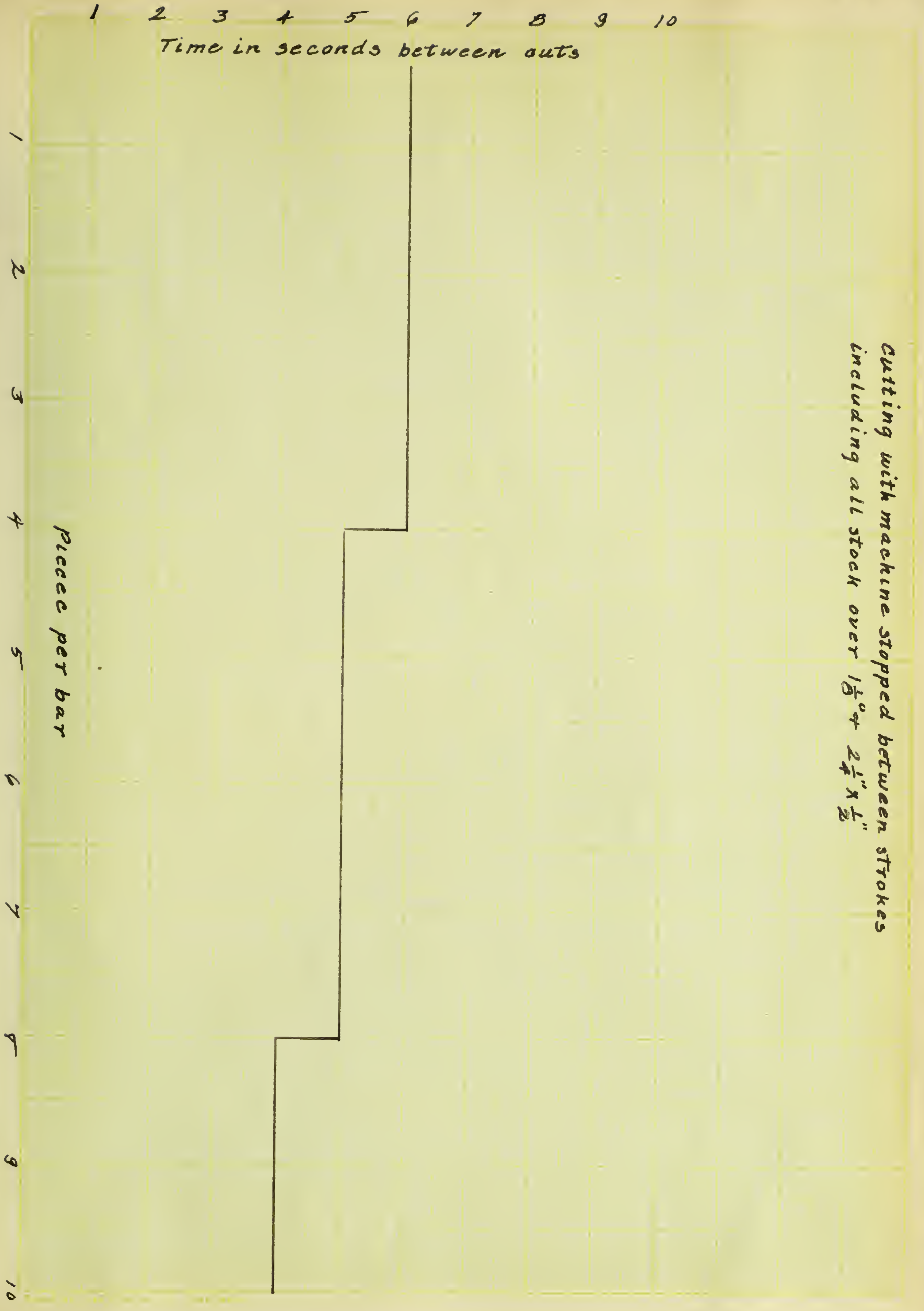
1 1/2" Round

Length of Piece	Pieces per Bar	Price A	Price B	Price C
3" & under	48	1.9	1.8	2.0
to 5	36	2.0	2.0	2.1
7	24	2.3	2.2	2.4
9	18	2.5	2.4	2.7
11	14	2 8	2.6	3.0
13	12	3.0	2.8	3.3
15	10	3.3	3.0	3.7
16	9	3.3	3.0	3.7
18	8	3 5	3.2	3.9
20.5	7	3.8	3.4	4.3
24	6	4.2	3.7	4.7
28.8	5	4 8	4.2	5.4
36.	4	5.6	4.8	6.4
		A&B		
	4	7.8		
	3	8.8		
	2	10.8		
	1	18.0		

Machine stopped between cuts.

PLATE 21


1 2 3 4 5 6 7 8 9 10
Time in seconds between cuts
1 2 3 4 5 6 7 8 9 10
Pieces per bar
Cutting with machine stopped between strokes
including all stock up to 1⅜° + 2¼" x ½"



Cutting with machine stopped between strokes including all stock over 1⅛" & 2¼" x ½"

Plate 23.

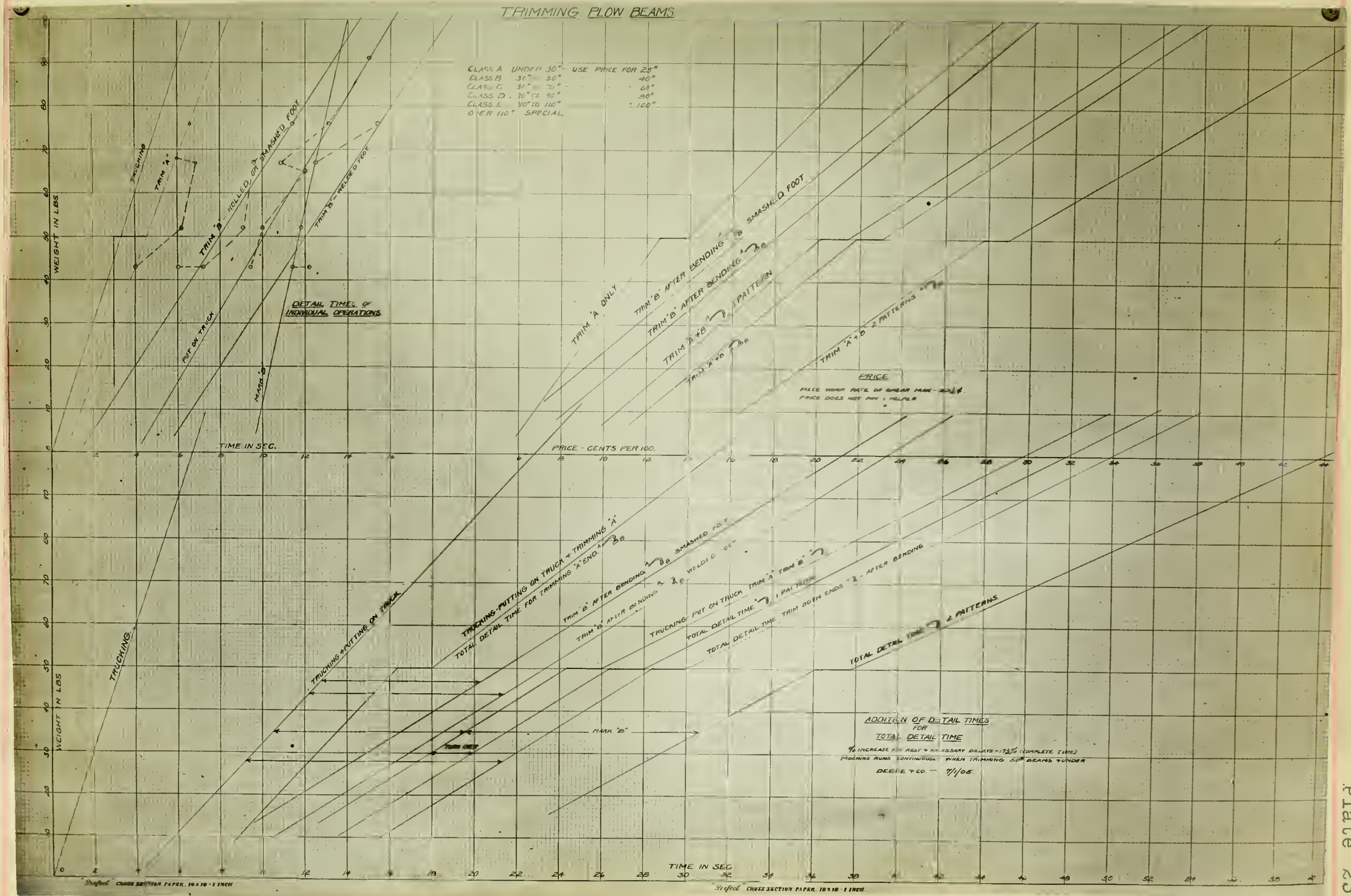

TRIMMING PLOW BEAMS
CLASS A UNDER 30" – USE PRICE FOR 25"
CLASS B 30" – 50" " " " 40"
CLASS C 51" – 70" " " " 60"
CLASS D . 70" TO 90" " " " 90"
CLASS E 90" TO 110" " " " 100"
OVER 110" SPECIAL.
DETAIL TIMES OF INDIVIDUAL OPERATIONS
TRUCKING
TRIM 'A'
TRIM 'B' – ROLLED OR SMASHED FOOT
TRIM 'B' – WELDED FOOT
PUT ON TRUCK
MARK 'B'
WEIGHT IN LBS
TIME IN SEC.
0
2
4
6
8
10
12
14
16
10
20
30
40
50
60
70
80
90
TRIM 'A' ONLY
TRIM 'B' AFTER BENDING A B SMASHED FOOT
TRIM 'B' AFTER BENDING A B
TRIM 'A'+B A 1 PATTERN
TRIM 'A'+B B
TRIM 'A'+B 2 PATTERNS A
PRICE
PIECE WORK RATE OF SHEAR MAN – 22½¢.
PRICE DOES NOT PAY HELPER
PRICE - CENTS PER 100.
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
TRUCKING
TRUCKING + PUTTING ON TRUCK
TRUCKING-PUTTING ON TRUCK + TRIMMING 'A'
TOTAL DETAIL TIME FOR TRIMMING 'A' END. A B
TRIM 'B' AFTER BENDING A B SMASHED FOOT
TRIM 'B' AFTER BENDING A B WELDED FOOT
TRUCKING PUT ON TRUCK TRIM 'A' TRIM 'B'
TOTAL DETAIL TIME A 1 PATTERN
TOTAL DETAIL TIME TRIM BOTH ENDS – AFTER BENDING
TOTAL DETAIL TIME 2 PATTERNS
MARK "B"
TRIM ONLY
WEIGHT IN LBS
TIME IN SEC
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
52
54
56
58
60
ADDITION OF DETAIL TIMES
FOR
TOTAL DETAIL TIME
% INCREASE FOR REST + NECESSARY DELAYS – 17½% (COMPLETE TIME)
MACHINE RUNS CONTINUOUSLY WHEN TRIMMING 50" BEAMS + UNDER
DEERE + CO. – 7/1/05.
"Stafford" CROSS SECTION PAPER. 10 X 10 - 1 INCH
"Stafford" CROSS SECTION PAPER. 10 X 10 - 1 INCH.

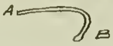
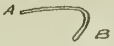
Plate 24

DATED:
July 1-'05
CANCELLING ALL PREVIOUS LISTS.

PIECE WORK PRICES.

TRIMMING PLOW BEAMS

DEPT. B
SEC. 1

CLASS.	 A WELDED LUG B			 A B SMASHED FOOT. Rolled Foot Same		 A B ROLLED FOOT.	
	TRIM "A" END ONLY COLD - AFTER BENDING.	TRIM "A"+"B" ENDS COLD - AFTER BENDING	TRIM "B" ONLY. COLD - AFTER BENDING	TRIM "B" BEFORE BENDING	TRIM "B" AFTER BENDING	TRIM "A"+"B" AFTER BENDING 1 PATTERN	TRIM "A"+"B" AFTER BENDING 2 PATTERNS
A	$.09	$.16	$.12		$.10	$.14	$.21
B	.11	.19	.16		.14	.18	.24
C	.16	.26	.20		.19	.24	.32
D	.20	.32	.25		.24	.31	.39
E	.24	.38	.30		.28	.37	.46

BEAM	CLASS	PRICE	BEAM	CLASS	PRICE	BEAM	CLASS	PRICE	BEAM	CLASS	PRICE	BEAM	CLASS	PRICE
AA	A		DA	A		3B	C		4M	C		6E		
AC	A		DB	A		3C	B		4N	C		6F		
AE	B		DC	A		3D	B		4O	D		6G		
AF	A		DE	B		3E	C		4P	E		6H		
AJ	B		DF	B		3F	B		4R	C		6J		
AK	B		DJ	B		3G	B		4S	B		6K		
AL	B		DS	B		3H	C		4T	C		6L		
AM	B		DU	B		3J	B		4U	D		6M		
AN	B		GA	B		3K	B		4W	C		6N		
AO	C		GB	C		3L	C		4X	B		6O	C	
AP	C		GC	B		3M	B		4Y	C		6P	C	
AR	C		GD	C		3N	B		4Z	D		6R	D	
AS	C		GF	B		3O	C		4AB	C		6S	D	
AT	C		GG	C		3P	B		4AC	D		6T	E	
AU	C		GH	B		3R	B		4AD	E		6U	C	
AW	B		GJ	C		3S	C		4AE	C		6W	C	
AX	C		GK	B		3T	C		4AF	C		6X	D	
AY	C		GL	C		3U	B		4AG	D		6Y	D	
BA	A		GM	C		3V	C		4AH.	E		6Z	E	
BB	A		GN	D		3W	C		5A	B		6AB		
BC	A		GO	C		3X	C		5B	B		6AC	C	
BE	B		GP	D		3Y	D		5C	C		*1	B	
BF	B		GR	D		3Z	C		5D	D		*2	C	
BJ	B		GS	E		3AB	C		5E	B		*3		
BK	B		GT	B		3AC	D		5F	B		*4		
BL	B		GU	C		3AD	D		5G	B		*5		
BM	B		GK2	B		3AF	D		5H	C		*6		
BN	B		GL2	C		3AH	B		5J	D		*7	B	
BO	B		GM2	C		3BH	B		5K	B		*8	C	
BP	C		GN2	D		3CH	B		5L	B		*9	B	
BR	B		GT2	B		3WE	C		5M	C		*11	C	
BS	B		GU2	C		4A	B		5N	D		*12	C	
BT	B		G2A	B		4B	B		5O	E		*13	B	
BU	B		G2B	C		4C	C		5P	C		*14	C	
BX	B		G2C	B		4D	B		5R	C		*15	C	
BW			G2D	C		4E	B		5S	D		*16	C	
BL1	B		G2E	C		4F	B		5T	D		*17	C	
BL2	B		G2F	C		4G	C		5U			*18		
BOA	A		G2H	B		4H	B		5W	C		*19	C	
BOB	A		G2J	B		4J	B		6A			*20	C	
BOC	A		TH.	C		4K	C		6B			*21	D	
BOD	A		3A	B		4L	D		6C			*22	C	

BEAM	CLASS	PRICE	BEAM	CLASS	PRICE	BEAM	CLASS	PRICE	BEAM	CLASS	PRICE
*23	D		88	D	NO WORK	152^{A}	C				
*24	C		92			153^{A}	D				
*25	C		93^{A}			154^{A}	E				
*26	D		94^{A}			155^{A}					
*27	C		95^{A}			156	B				
*28	D		97	C	NO WORK	157	B				
*29	B		100			158	B				
31	C		101			159	D				
32	C		102			160	B				
33	C		103			161	C				
34			104			162	B				
35	B		105			163	A				
36	C		106			164	B				
37	B		107			165	A				
38	B		108			166	B				
39	C		109			167	B				
41	B		110			168	B				
42	C		111			169	B				
43	C		112			170	C				
44	D		113			171	C				
45	C		114			172	B				
46	D		115			173	B				
47	C		116			174	C				
48	D		117			175	B				
49	C		118			176	D				
51	C		119			177	B				
52	D		120			178	B				
53	E		121	C		179	A				
54	C		122	C		180	A				
55	B		123	A		181	C				
56	C		124	B		182	C				
57	B		125	B		183	B				
58	C		126	C		184	B				
59	B		127	D		185	A				
62	B		128	B		186	B				
63	B		129	B		187	B				
64	D		130	C		188	B				
65	B		131	C		189	B				
67	B		132	C		190	B				
68	B		133	C		191	B				
69	B		134	C		192	B				
70	C		135^{A}	C		193	C				
71	B		136^{A}	D		194	D				
72	C		137^{A}	E		195	E				
73	C		138^{A}			196	B.				
74	B		139	C		197					
75	C		140	C		D&M B704	A				
76	B		141	C		D&M. LISTER	C				
77	C		142	D							
78	C		143^{A}	C							
79	C		144^{A}								
80	B		145^{A}								
81	B		146^{A}								
82	B		147^{A}								
83^{A}	C		148^{A}								
84^{A}	D		149^{A}								
85^{A}	E		150	B							
87^{A}			151	C